Forestry Canada Forêts Canada

Forest pest conditions in the Maritimes in 1988

Laszlo P. Magasi

Information Report M-X-174
Forestry Canada - Maritimes

Forestry Canada

Forestry Canada is the main focus for forestry matters in the federal government. It provides national leadership through the development, coordination, and implementation of federal policies and programs to enhance long-term economic, social, and environmental benefits to Canadians from the forest sector.

The Department is a decentralized organization with six regional forestry centres, two national research institutes, and seven regional sub-offices located across Canada. Headquarters is located in the national capital region, in Hull, Quebec.

In support of its mandate, Forestry Canada carries out the following activities:

- Administers forest development agreements negotiated with the provinces
- Undertakes and supports research, development, and technology transfer in forest management and utilization.
- Compiles, analyzes, and disseminates information about national and international forest resources and related matters.
- Monitors disease and insect pests in Canada's forests.
- Provides information, analyses, and policy advice on economics, industry, markets, and trade related to the forest sector.
- Promotes employment, education, and training opportunities in the forest sector.
- Promotes public awareness of all aspects of the forest sector.

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Forêts Canada est l'organisme principal en matière de foresterie à l'intérieur du gouvernement fédéral. Chef de file sur le plan national, il assure la préparation, la coordination et la mise en oeuvre des politiques et programmes fédéraux dans le but d'améliorer les avantages économiques, sociaux et environnementaux à long terme offerts aux Canadians par le secteur forestier.

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- il entreprend et appuie la recherche, la mise au point et le transfert technologique dans le domaine de la gestion et de l'utilisation des forêts
- il rassemble, analyse et diffuse de l'information sur les ressources forestières nationales et internationales et les domaines connexes
- il fait des relevés des maladies et des insectes ravageurs des forêts canadiennes
- il fournit de l'information, des analyses et des conseils (quant aux politiques) concernant l'économie, l'industrie, les marchés et le commerce reliés au secteur forestier
- il favorise les occasions d'emploi et de formation universitaire et technique dans le secteur forestier
- il encourage les Canadiens à prendre conscience de tous les aspects du secteur forestier.

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FOREST PEST CONDITIONS IN THE MARITIMES

IN 1988

by

Laszlo P. Magasi

Information Report M-X-174

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ABSTRACT

This report reviews the status of forest insects and diseases in the Maritimes Region in 1988 and forecasts conditions for 1989, when appropriate. Economically important pests of current concern are discussed in some detail, other organisms are listed in tabular form. A separate chapter discusses the various special involvements with related activities, such as the use of pheromones as survey tools, the Acid Rain National Early Warning System (ARNEWS), and others. A list of forest pest related publications and reports is included. More detailed information is available from Forestry Canada - Maritimes.

RÉSUMÉ

Ce rapport fait le bilan des insectes et maladies des arbres de la région des Maritimes en 1988, et donne un aperçu des conditions prévues pour 1989, lorsqu'approprié. Les ravageurs d'importance courante y sont traités en détail, les autres organismes sous forme tabulaire seulement. Les implications du RIMA dans des activités connexes, telles que l'usage de phéromones comme outils de relevé, le Dispostif national d'alerte rapide pour les pluies acides (dnarpa), et autres efforts, sont traitées dans un chapitre particulier. On y inclus une liste de publications et de rapports traitant de ravageurs forestiers. De plus amples renseignements sont disponsibles au Forêts Canada - Maritimes.

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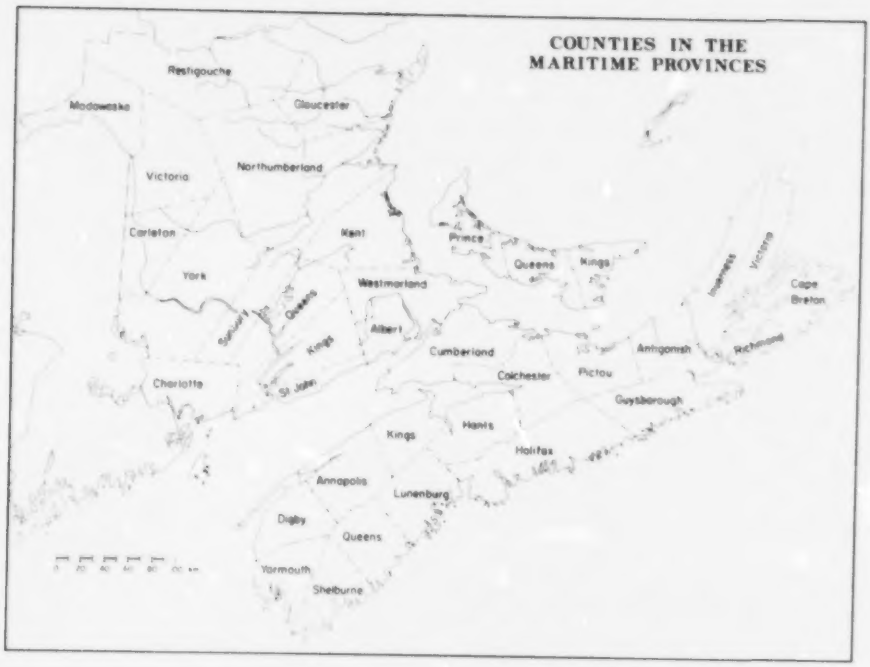
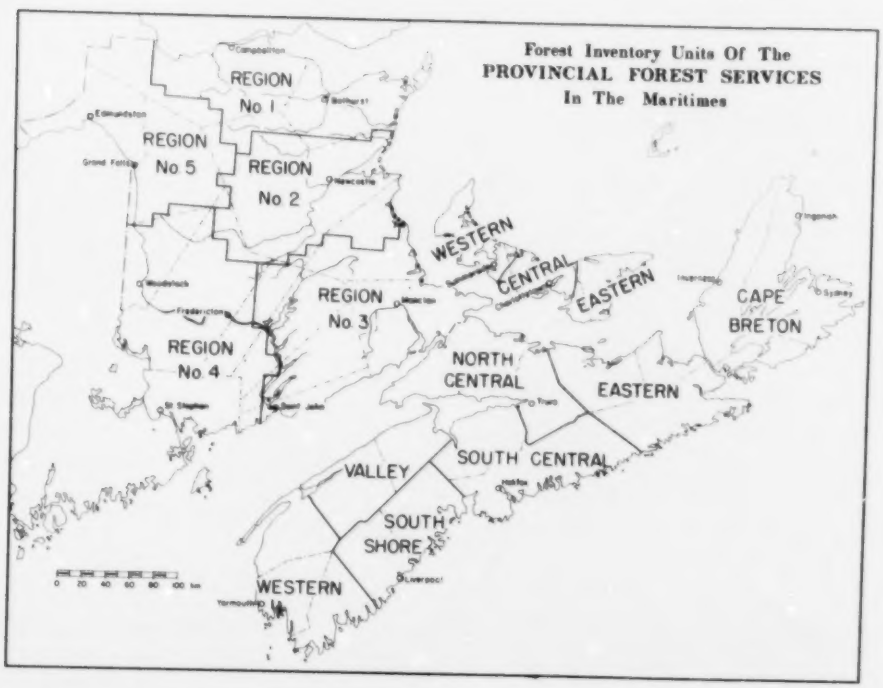

COUNTIES IN THE
MARITIME PROVINCES
Restigouche
Madawaska
Gloucester
Victoria
Northumberland
Carleton
Kent
Prince
Queens
Kings
York
Westmorland
Cape
Breton
Sunbury
Queens
Albert
Kings
Cumberland
Antigonish
Richmond
Charlotte
St John
Colchester
Pictou
Guysborough
Hants
Kings
Halifax
Annapolis
Lunenburg
Digby
Queens
Yarmouth
Shelburne


Forest Inventory Units Of The
PROVINCIAL FOREST SERVICES
In The Maritimes
REGION
No 1
REGION
No 5
REGION
No 2
REGION
No 3
REGION
No 4
WESTERN
CENTRAL
EASTERN
CAPE
BRETON
NORTH
CENTRAL
EASTERN
SOUTH CENTRAL
VALLEY
SOUTH
SHORE
WESTERN

INTRODUCTION

Some of the objectives of the Forest Insect and Disease Survey are to monitor insect and disease conditions, determine their effects on the forest, and report on the status of important and common pests. In the Maritimes, this information is disseminated to interested agencies and individuals through periodic reports, such as Seasonal Highlights, Technical Notes, Information Reports, and the Annual Report of the Forest Insect and Disease Survey.

In this report, pest conditions in 1988 are described; operational control programs against the spruce budworm, Scleroderris canker, gypsy moth, spruce budmoths, Sirococcus shoot blight, seedling debarking weevil and Dutch elm disease are outlined; forest pest related research programs connected with the aims of the Forest Insect and Disease Survey are briefly mentioned; and a list of reports and publications relating to forest pest conditions is included.

The report aims to provide forest managers with information on pest conditions in the Maritime Provinces early enough that it can be considered in management decisions before the start of the 1989 field season. Insects and diseases that were widespread and caused considerable concern in 1988 are discussed in detail, others are presented in tabular form. More information on these and on other specific conditions will be provided by Forestry Canada - Maritimes upon request.

We have been presenting a chapter on special surveys to report on some of our projects that have implications for forest management. In 1988, this chapter includes: a summary of plantation pest assessment surveys carried out in cooperation with the provincial forestry services and several companies; regional surveys for the pinewood nematode, a pest of importance to international commerce and of concern to plant quarantine organizations; a description of the North American Sugar Maple Decline Project; a brief statement on the status of work on pheromones and other attractants used as tools for detecting the presence and monitoring the spread and fluctuation of forest insects; and a section which deals with the Acid Rain National Early Warning System (ARNEWS).

We attempt to add extra information on the pests discussed, in response to suggestions, and because requests for information indicate the need for it, now that our readership has expanded beyond our traditional clientele of the forestry community. This will, we hope, place the organisms in a better perspective and provide readers with some background and a clearer understanding of the concerns we express. Comments on any part of the report for improved presentation are always welcome.

Two maps are included on the page facing this introduction to help the reader locate areas mentioned. One shows the counties of the three provinces and the other indicates the provincial forest services' forest inventory subdivisions.

In recent years, efforts towards collecting and reporting information in quantitative terms have been emphasized but, for a variety of reasons, it will never be possible to express all observations quantitatively. Throughout this report, the terms "severe, moderate, light, and trace" are used to describe the level of defoliation and, in some cases, other injury or insect population levels. Unless otherwise stated, the terms have the following ranges:

Trace	up to 5%
Light	6 - 29%
Moderate	30 - 69%
Severe	70 - 100%

The cover of the report serves as a reminder of the pinewood nematode-vector survey, conducted nationally in 1988. Depicted is a log pile, representing all forestry operations, and a sawyer beetle, representing all possible vectors of pinewood nematode. A bad combination of these could threaten Canadian lumber exports.

SUMMARY

In 1988, **spruce budworm** caused moderate and severe defoliation over 500 000 ha in New Brunswick, almost all in the northern half of the Province. There was no defoliation detected during aerial surveys in either Nova Scotia or Prince Edward Island. Control operations were conducted only in New Brunswick and covered some 546 000 ha. It is predicted that infestations in New Brunswick will affect about 1.65 million ha. No significant defoliation is likely to occur either in Nova Scotia or Prince Edward Island.

Stillwell's syndrome, the sudden death of balsam fir trees, mostly in spruce budworm affected

stands, occurred throughout the Maritimes but was present at generally low levels.

Spruce beetle activity decreased in New Brunswick, remained stable in Nova Scotia and increased in Prince Edward Island. Newly attacked, dying, and dead white spruce stands were observed in both Nova Scotia and Prince Edward Island.

Eastern larch beetle populations were generally low in the Region, although newly attacked trees were found in more areas in New Brunswick than during the past few years.

European larch canker remained confined to areas already known to be affected in southeastern New Brunswick and mainland Nova Scotia.

Scleroderris canker was found in only a few plantations in New Brunswick. All new infections were of the North American race. Two more plantations with the non-North American race were "sanitized", leaving only four of the eleven locations in the "under surveillance" category. The 11-year effort regarding the non-North American races gives rise to cautious optimism as to the future of these diseases in the Region.

Spruce budmoths damaged an average of 10%, 12%, and 7% of white spruce shoots in New Brunswick, Nova Scotia and Prince Edward Island, respectively. Damage occurred throughout the Region and reached as high as 71% in an area in Annapolis County, N.S. The adulticide control program in New Brunswick appears to be successful.

Seedling debarking weevil caused seedling mortality in newly established plantations in all three provinces. At least some damage occurred in 30% of plantations surveyed in New Brunswick, 100% in Nova Scotia and 61% in Prince Edward Island. This insect has become one of the major threats to the success of plantation establishment. Efforts to minimize losses are continuing and some offer promises for successful pest management.

Armillaria root rot killed both young and old trees. The disease was common in young spruce and pine plantations and at least some tree mortality was recorded in 16% and 8.5% of the plantations assessed in New Brunswick and Nova Scotia, respectively; tree mortality also occurred in Prince Edward Island. The disease also killed trees in all three provinces in natural stands, seed orchards or Christmas tree areas.

Sirococcus shoot blight remained the most serious plantation problem of red pine in western Nova Scotia and also caused damage in Prince Edward Island and southern New Brunswick. Previously infected plantations continued to deteriorate and some of those in western Nova Scotia are virtually "wiped out".

Pine leaf adelgid infestations last year resulted in an average of 21% white pine shoot mortality in 1988 in parts of the south shore of western Nova Scotia. Shoot damage on red spruce averaged 3%.

Balsam woolly adelgid populations appear to be on the rise as indicated by more frequent observations of stem attack, mostly in New Brunswick.

A number of **rusts** affected various coniferous and hardwood species but the only major problem encountered in 1987 was ash rust, a persistent disease of ash mostly affecting western Nova Scotia, which has proven to be a tree killer. A leaf rust was found on oak in New Brunswick. It alternates to jack pine and causes galls undistinguishable from those caused by the microcyclic *E. harknessii* (globose gall rust).

Hemlock looper populations were generally low and little defoliation resulted from feeding.

Whitemarked tussock moth caused various levels of defoliation in small areas in all three provinces.

Gypsy moth populations were present at 10 locations in New Brunswick and at 13 locations in Nova Scotia. The insect appears to be established in southwestern Charlotte County, New Brunswick and at a few isolated areas, mostly in communities, in western Nova Scotia. The Gypsy Moth Coordinating Committee was again in charge of overseeing all cooperative surveys, including the 5871-trap pheromone survey. Control operations were conducted in both New Brunswick and Nova Scotia under the direction of various lead agencies.

Oak leafroller and oak leaf shredder caused serious defoliation of red oak over 22 800 ha in western Nova Scotia and in a few localized areas of New Brunswick. As a result of repeated defoliation by these insects, trees in red oak stands are deteriorating and serious crown dieback is common in the affected areas.

Other hardwood defoliators were "quiet" in 1988 and caused no more than localized defoliation. They are included in the summary table in the report with pertinent remarks.

Birch casebearer caused varying degrees of foliage browning in many areas of the Region, affecting birch and alder.

Birch leafminer caused foliage browning, the intensity of which increased in Nova Scotia, decreased in New Brunswick, and remained about the same in Prince Edward Island as last year. Severe discoloration occurred only in a few areas of Nova Scotia.

Ambermarked birch leafminer caused birch leaf browning in a few areas in both New Brunswick and Nova Scotia but the intensity of discoloration was generally low.

Birch skeletonizer was more common in Nova Scotia than in past years and caused moderate and, in a few cases, severe discoloration of white birch in isolated pockets throughout the Province.

Larch casebearer populations remained generally low and caused only trace or light needle discoloration in the three provinces. Moderate browning occurred in only a few small patches of trees in Nova Scotia.

Poplar serpentine leafminer populations were high in New Brunswick, intensifying in the north and spreading towards the south, generally low in Nova Scotia, and very low in Prince Edward Island.

Drought-induced stress caused extensive lower branch mortality on hardwoods, predominately sugar maple, in most of New Brunswick and in scattered areas of Prince Edward Island, but not in Nova Scotia. Branch mortality occurred in urban and roadside rural situations but not inside natural stands. Some of the seriously affected trees died.

Dutch elm disease intensified within the known area of distribution but did not spread significantly in New Brunswick and Nova Scotia. In Prince Edward Island, however, a major change occurred in the distribution of the disease with the discovery of an infected tree at Alberry Plains, Queens County, extending the known limits of the disease eastward by some 90 km.

Seed orchard pests, with few exceptions, were mostly of localized importance, although a heavy cone crop in 1988 supported a great variety of organisms.

Nursery and greenhouse problems were mostly abiotic in nature, were often caused by management practices, and resulted in the death of millions of seedlings.

The **Christmas tree pests** balsam gall midge and balsam twig aphid were present at generally low populations except for a few spot infestations at widely separated locations. Yellow witches' broom infections were also lower than in previous years. Drought caused stress, especially on poor sites, and branch mortality or needle shedding resulted, rendering some trees unmarketable.

The **Acid Rain National Early Warning System** program continued in 1988 with assessment of conditions on all 17 ARNEWS plots, and determination of foliage retention on about 350 locations throughout the Maritimes. Average tree mortality from all causes on all Maritimes ARNEWS plots is 1.6% per year between 1984 and 1988. Red spruce plots, established in 1986, were reassessed and trees found in generally better condition than last year. Leaf browning of white birch was detected during aerial surveys along the Bay of Fundy in both New Brunswick and Nova Scotia (and in some other areas in Nova Scotia), although later in the season than usual. The condition deteriorated further. White spruce foliage yellowing at Loch Katrine, Antigonish County, N.S., occurred again in 1988 and we have no explanation as to the cause.

Pinewood nematode surveys at 228 locations, involving some 420 trees, were conducted in 1985-1988. The pinewood nematode ("r" form) was found at five locations in New Brunswick. In 1988, a vector survey was conducted which yielded almost 1700 insect specimens. The effort is being expended to clarify some biological questions threatening the annual export of over $300 million worth of Canadian lumber to Europe.

Cooperative multi-agency **plantation pest surveys,** involving federal and provincial forestry services and industry, were conducted in all three provinces. There were 268 plantations and 11 thinned areas assessed, involving some 19 000 trees. Over 90% of the pine, spruce, and larch trees were classified as healthy but there were a number of

plantations with at least some moderate or severe problems.

The **condition of sugar maple** remained a major concern and further studies were initiated, to find decline and explain the cause, under the North American Sugar Maple Decline Project.

Pheromone surveys, were carried out for spruce budworm (an international, inter-regional research effort), forest tent caterpillar, jack pine budworm, European pine shoot moth, oak leafroller, oak leaf shredder, spruce budmoths, spruce coneworm, seedling debarking weevil, and gypsy moth. Many of these are still in the development or calibration phase.

Light traps were operated at 15 locations in the Maritimes, many of them by cooperators, and capture-results along with other information, in forecasting insect populations for 1989.

Other insects and diseases encountered in 1988 but not discussed in detail are presented in tabular form. Remarks explain their current status.

A list of publications dealing with forest insects and diseases, authored or co-authored by staff from Forestry Canada - Maritimes, is included for reference. About 20 reports are listed.

IMPORTANT AND CONSPICUOUS FOREST PESTS

SPRUCE BUDWORM

Information presented on the spruce budworm, *Choristoneura fumiferana* (Clem.), is summarized from various sources: New Brunswick Department of Natural Resources, Forest Protection Limited, J.D. Irving Limited, Nova Scotia Department of Lands and Forests, Prince Edward Island Department of Energy and Forestry, and Forestry Canada -Maritimes. Both published and unpublished data were used with permission, and the cooperation of all organizations is acknowledged. More detailed information is available from the various sources.

Spruce budworm populations have shown a marked downward trend in eastern North America during the last few years and, although the insect is still one of the major defoliators in the fir-spruce forest, the area of defoliation is declining.

New Brunswick

Defoliation of balsam fir and spruce stands was recorded on 543 000 ha in the Province in 1988 (Fig. 1). Defoliation was severe on 304 000 ha, moderate on 196 000 ha and light on 43 000 ha. The 500 000 ha of severe and moderate defoliation was only slightly larger than the 430 000 ha recorded in these categories in 1987. Most defoliation occurred in the northern half of the Province.

Damage - There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in New Brunswick in 1988.

Control operations - Foliage protection against the spruce budworm in New Brunswick was conducted over 546 200 ha in 1988: 448 000 ha by Forest Protection Ltd. and 98 200 ha by Forest Patrol Ltd., a subsidiary company of J.D. Irving Ltd.

Forest Protection Ltd. treated approximately 238 000 ha of forest with two applications of the chemical insecticide fenitrothion (Sumithion®), and approximately 210 000 ha with the biological insecticide *B.t.* (Dipel 132® and Futura XLV®). The rates of application were primarily 2 x 210g/ha for fenitrothion, and 1 x 30 BIU/ha for *B.t.* Most of the chemical treatments were applied in water-based formulations, while *B.t.* was applied undiluted.

Forest Patrol Ltd. used fenitrothion (Sumithion®) in two applications on 70% of the treated area (68 000 ha) and one application on 15% (14 800 ha). A single application of fenitrothion, followed by an application of *B.t.* (Dipel 176®) was used on 10% (10 200 ha) and 5% received a single application of B.t. (4 600 ha).

Fenitrothion was applied at the rate of 210 g/ha, in either ULV (ultra-low-volume; 0.73 l/ha) or UULV (ultra-ultra-low-volume; 0.42 l/ha) spray mixtures. The *B.t.* product (Dipel 176) was applied at 1.78 l/ha to deliver 30 BIU/ha in a single application.

Forecast - The overwintering larval (L_2) survey was conducted by the New Brunswick Department of Natural Resources at 1204 locations. Approximately 350 locations, sampled in previous years, were not sampled in the southern part of the Province where the infestation has collapsed over

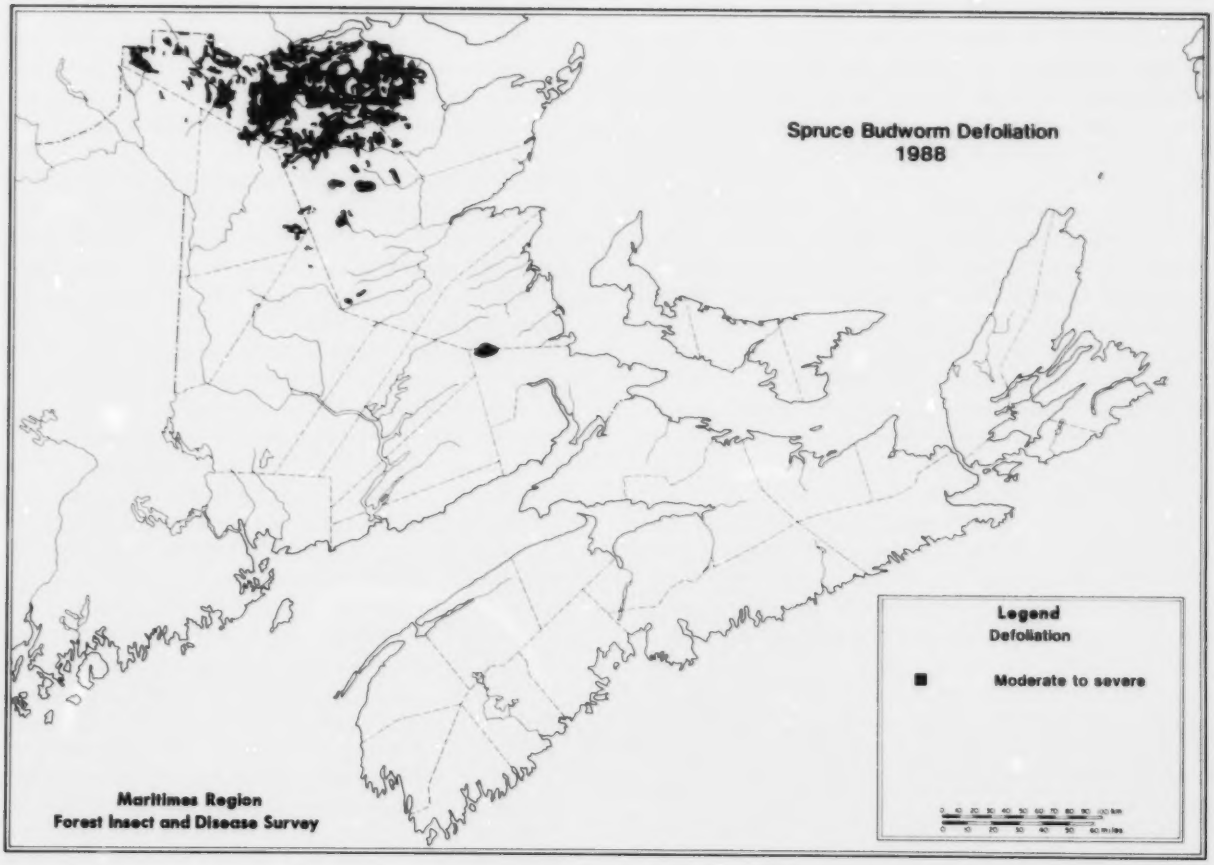


Figure 1

the past several years. L_2 populations of spruce budworm were low at 73%, moderate at 19% and high at 8% of the areas sampled. The forecast for 1989 is for 1.65 million hectares of variable and moderate to severe defoliation. The most severe damage is expected to occur in the northern part of New Brunswick. No significant damage is expected in the southern half of the Province or throughout much of the western and eastern areas.

Nova Scotia

Defoliation - For the second consecutive year, there was no defoliation of balsam fir or spruce detectable during the annual spruce budworm aerial survey in Nova Scotia in 1988. Only trace defoliation was detected during ground surveys on small groups of trees in previously damaged areas of the Province.

Damage - There were no specific budworm damage surveys conducted by the Forest Insect and Disease Survey in Nova Scotia in 1988.

Control operations - No control measures on an operational scale were carried out against the spruce budworm in Nova Scotia in 1988.

Forecast - The overwintering larval (L_2) survey was conducted by the Nova Scotia Department of Lands and Forests, with sampling assistance from Bowater-Mersey Ltd. personnel. Information from 224 sample locations indicates that the dramatic decline of spruce budworm populations continues. L_2 populations were negative at 61%, low at 38%, and moderate at 1% of the locations sampled. Moderate populations were found only in Antigonish (1 of 14 samples) and Annapolis (2 of 16 samples) counties. Defoliation, if any, in 1989 is expected to be confined to small, isolated patches of fir and spruce trees in these counties.

Prince Edward Island

Defoliation - For the second consecutive year, there was no defoliation of balsam fir or spruce

detectable during the annual spruce budworm aerial survey in Prince Edward Island in 1988. Ground surveys detected moderate and light defoliation only in scattered white spruce stands and hedges in the Cardigan, Montague and Georgetown areas in the southern part of Kings County in eastern Prince Edward Island.

Damage - There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in Prince Edward Island in 1988.

Control - No control measures on an operational scale were carried out against the spruce budworm in Prince Edward Island in 1988.

Forecast - The survey of overwintering larvae (L_2) was conducted by Forestry Canada - Maritimes at 40 locations. Populations were reduced again from 1987 indicating that no significant defoliation is to be expected in 1989. Populations were high at 3%, moderate at 13%, low at 65% and nil at 20% of the locations sampled.

STILLWELL'S SYNDROME
(Sudden death of balsam fir trees)

Stillwell's syndrome, a condition of balsam fir, occurs when trees, usually with a fair complement of foliage, despite having been exposed to varying amounts of defoliation by the spruce budworm for several years, turn bright red and die. This phenomenon has been known to occur in balsam fir stands where considerable damage or mortality has occurred. The "dropping out" of surviving trees in spruce budworm damaged stands during the apparent recovery stage, even years after the collapse of the outbreak, has been referred to as Stillwell's Syndrome since 1982, when the Forest Insect and Disease Survey first drew attention to the condition.

Balsam fir trees stressed by repeated spruce budworm defoliation are susceptible to attack by numerous organisms that are normally considered to be secondary in nature. Investigations in 1982 found that all red trees sampled were affected by Armillaria root rot and at least one species of beetles. Balsam bark weevil was present in 75% of the affected trees, balsam fir bark beetle in 17%, and sawyer beetle in 17%. However, observations elsewhere indicate that not all Stillwell's Syndrome-killed trees are affected by Armillaria root rot, that balsam bark weevil and balsam fir bark beetle frequently occur together on the same tree, and that sawyer beetle attack of weakened living trees is not uncommon.

Sudden death of balsam fir trees was reported in 1980 and 1981, from various parts of New Brunswick. In 1982, an unusually high number of balsam fir trees died in this manner and some areas of Nova Scotia were affected. The condition was present but much reduced in 1983, increased again in 1984 and continued in 1985, especially in the northwestern part of New Brunswick. The problem continued to intensify in New Brunswick in 1986 and literally thousands of balsam fir trees with bright red foliage were observed during early summer aerial surveys in the western part of the Province. The number of trees with Stillwell's Syndrome was greatly reduced in 1987 in New Brunswick and Nova Scotia, although affected trees were found throughout these provinces. No affected trees were observed in Prince Edward Island.

In 1988, the number of trees affected by Stillwell's syndrome was generally low, but mortality occurred throughout the three provinces. In New Brunswick, the distribution of newly killed trees was very uniform; in Nova Scotia, dead trees were more numerous in Colchester-Cumberland counties, the area of the most recent spruce budworm outbreak. In Prince Edward Island, where mortality was higher than last year, numerous trees were killed in an area of about 10 ha at Iris, Kings County, where hemlock looper has defoliated trees in recent years. Mortality was also common along the Montague River in Kings County, at Hampshire, Queens County and at Mount Royal, Prince County. At Belfast, Queens County, four white spruce trees died of Stillwell's syndrome.

BARK BEETLES OF CONIFERS

Not as conspicuous as some defoliators, bark beetles are nonetheless an important group of forest insects causing tree mortality. Bark beetles usually attack trees that have been weakened by other factors, but when populations are at outbreak levels, healthy trees are also successfully attacked and may be killed.

Spruce beetle, *Dendroctonus rufipennis* (Kby.), remained active throughout the Region in 1988 and white spruce mortality occurred in all three provinces.

In New Brunswick, spruce beetle damage was reported in 1980 after a 50-year period of inactivity. Since then, the insect has been found in a number of widely separated areas, mostly in the southeastern and northwestern parts of the Province.

In 1988, spruce beetle populations declined sharply from levels of previous years and no newly infested trees were found at any of the known infestation areas, including those with the longest history along the Shepody Road in Fundy National Park and on Grand Manan Island. A single infested white spruce tree was found in the Tracy Brook area in Restigouche County.

In Nova Scotia, Cape Breton Island constituted the major outbreak area during the early part of the 1980s and, by the end of 1983, no large areas remained without severe white spruce mortality. Beetle activity decreased between 1984 and 1986 on Cape Breton Island, but there was an increase in the number of spruce beetle-attacked white spruce on the mainland. In 1987, the level of insect activity remained similar to that observed in 1986 with most of the tree mortality occurring on Cape Breton Island and on the northern mainland.

In 1988, the status of spruce beetle remained similar to that observed in 1987, with white spruce mortality occurring in scattered pockets in many areas of the Province. The majority of infestations were observed in northern Antigonish and Pictou counties and on Cape Breton Island.

Damage (infested living and dead trees) averaged 14% in stands examined and ranged from 0% to 20% in individual stands. The infested stand reported in 1987 at Big Mushamush Lake, Lunenburg County, was salvage-cut in 1988 but some infested trees still remain in the area.

In Prince Edward Island, spruce beetle killed an estimated one-third of the merchantable white spruce by 1983 when infestations peaked. Populations have decreased steadily since that time and in 1986 only a very few newly infested white spruce trees were observed in the Province. There was an increase in infestations in 1987.

In 1988, infestations increased further and newly attacked or recently dead trees were observed in several areas in Kings and Queens counties, including Cavendish and Rustico Island in Prince Edward Island National Park.

Eastern larch beetle, *Dendroctonus simplex* Lec., normally attacks only weakened, damaged, or recently felled host material. However, at very high populations, living, apparently healthy, mature or overmature trees, and even younger, small diameter trees, can also become infested.

In the Maritimes, a population buildup was first noticed in Nova Scotia in 1976. This increase in the beetle population followed several years of severe defoliation of larch by the larch sawfly, *Pristiphora erichsonii* (Htg.). Since then, the beetle has become widespread in all three provinces and has caused serious tree mortality. By the end of 1981, an estimated 24% of merchantable-size larch was dead in New Brunswick, 64% in Nova Scotia, and 13% in Prince Edward Island. The insect populations have been generally declining since 1984 and the number of trees succumbing to beetle attack has also decreased in most areas.

In 1988, in New Brunswick, dying and recently dead larch trees were more common than during the past few years. Small patches of infested trees, mainly in mature and semimature stands, were present in areas of Charlotte, Queens, Kings, Kent and Northumberland counties, while scattered individual, newly infested trees, indicating activity by the insect, were observed in Sunbury, York, Carleton and Victoria counties.

There were no newly infested trees found at the central New Brunswick research plot in 1988. This compares to 7.6% in 1987, 6.7% in 1986, 2.8% in 1985, 3.8% in 1984 and 2.9% in 1983. Cumulative larch mortality due to attack by the eastern larch beetle has increased from 6% in 1979, when the plot was established, to 42% in 1987, an average of 4.7% annual tree mortality during those years.

In Nova Scotia, no eastern larch beetle infested trees were found.

In Prince Edward Island, affected trees were found at Wellington, Prince County where trees are in various stages of decline in an area of approximately 3 ha.

CANKERS OF CONIFERS

Cankers are caused by many fungi, the attacks of which are manifested in different ways. However, all are similar in one important aspect: they damage

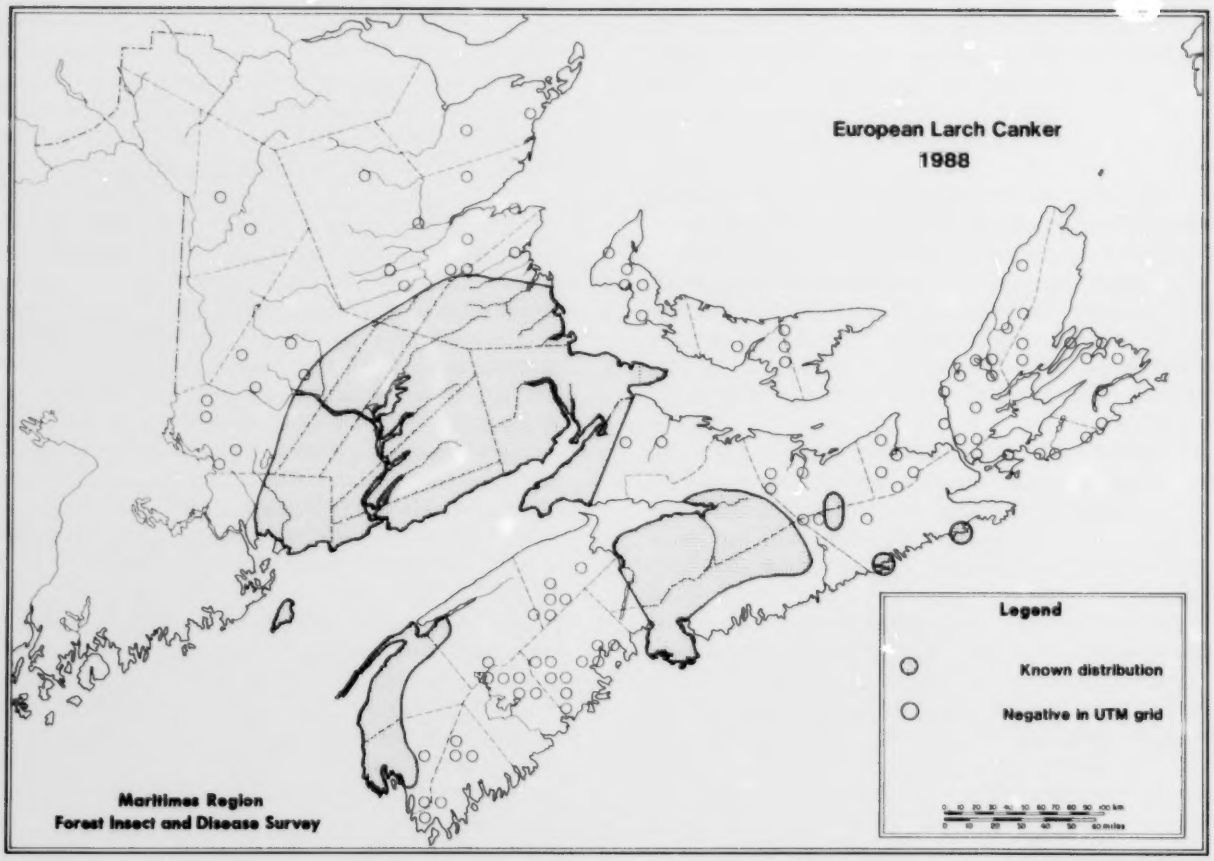


Figure 2

trees. Damage ranges from the loss of a few small branches, or minor stem infections, to the deformation of the stem to such an extent that it becomes of little or no value, or to tree mortality. Damage in stands is also variable. Some canker diseases eliminate only a few trees, while others may spread and infect most or all of the trees in a stand or plantation. Losses are both direct, such as mortality or reduction in wood value, and indirect, such as low quality trees occupying valuable space or affected trees serving as sources of infection either to other trees in the same stand or to areas nearby.

European larch canker, caused by the fungus *Lachnellula willkommii* (Hartig) Dennis, was first discovered in the Maritimes in 1980. Surveys since then established the distribution of the disease as widespread in southeastern New Brunswick and on mainland Nova Scotia. European larch canker has been a serious disease in many parts of Europe. The fungus is considered, by most, to be a primary pathogen (capable of infecting vigorous, healthy trees) and its presence has resulted in the exclusion of larch from plantation programs in parts of Europe. In North America, the fungus was first found in Massachusetts in the 1920s in European larch plantations. Periodic concentrated eradication attempts appeared to have been successful as the disease was not found during surveys of the area in 1965. However, it was re-discovered in northeastern Maine in 1981.

The fungus mostly infects young trees and, therefore, future wood supplies may be affected. Tree mortality reduces stocking, branch mortality reduces growth, and cankers reduce wood quality. The extent to which the disease will cause damage in the Maritimes is not yet known but the potential for damage is there and the role of the disease will have to be considered in view of increased emphasis

on forest renewal and larch tree improvement programs.

In 1988, the disease was not found outside the range of the known distribution during surveys of 100 locations, 23 in New Brunswick, 68 in Nova Scotia and 9 in Prince Edward Island (Fig. 2). Of 26 locations examined within the quarantine zone in southeastern New Brunswick, infected trees were found in 6 areas, the incidence ranging from 4% to 32%. In Nova Scotia, larch was found to be infected at 4 of the 15 locations examined within areas of the known distribution. The Nova Scotia surveys included 20 plantations of eastern, European, Japanese and Siberian larch, all of which were found free of the disease. European larch canker is not known to be present in Prince Edward Island.

Investigation of several aspects of the behavior of the fungus under our climatic conditions has been initiated. Results are reported as they become available. A survey to establish age and spread pattern indicates that the fungus could have been present in the Maritimes for about two decades before its discovery and may have spread from specific areas. The study also showed a rapid decrease in incidence of infected trees with increasing distance from the Bay of Fundy, possibly indicating a climatic dependence.

The disease is capable of intensifying rapidly in young stands. Incidence of infected trees in a research plot increased as follows, based on fall assessments: 1982 - 7%; 1983 - 19%; 1984 - 46%; 1985 - 88% and 1986 - 91% of trees affected. Considering the high level of incidence, this study was terminated at that point.

Greenhouse-grown seedlings of 22 populations of *Larix decidua*, *L. leptolepis*, *L. eurolepis*, *L. laricina*, and *L. sibirica* were successfully planted in a heavily infected area in the early summer of 1983 to test differences in susceptibility to infection. *Larix occidentalis* seedlings were added to the test in 1985. Cankers, bearing fruiting bodies of *Lachnellula willkommii*, were found on three *L. decidua* seedlings in the fall of 1984. By the fall of 1985, 11 of the 24 living larch populations had at least one seedling infected by the disease. The species affected were *L. decidua*, *L. leptolepis* and our native tamarack, *L. laricina*. Two additional larch populations became infected in 1987. One of these represents the first infection of *L. eurolepis* in the study. Additional seedlings of already affected populations became infected both in 1986 and 1987. No information is available on the 1988 results.

Scleroderris canker, caused by the fungus *Gremmeniella abietina* (Lagerb.) Morelet, was first found in the Maritimes Region in 1971. The disease is widespread in New Brunswick, especially in the northern half of the Province and mostly infects plantations of jack, red and Scots pine. In Nova Scotia, where the disease was first found in 1972, a few plantations of red, jack and Scots pine suffered limited lower branch mortality during the mid-1970s. The disease was last found in that Province in 1978 and appears to have died out. It has never been found in Prince Edward Island.

After some years of minimal activity, there was an upsurge of new infections in New Brunswick in 1987, likely the result of the ideal weather conditions (wet and cool) during the infection period in 1986.

In 1988, the disease was found in Carleton, Victoria, Madawaska and Restigouche counties in New Brunswick in a few plantations of jack pine, red pine, and scots pine and in a jack pine seed orchard. Race determination results are not yet available but, all infection being confined to the lower 2 m of the affected trees, no European race is suspected.

The European race of Scleroderris canker is capable of killing trees of any size (the North American race kills only small trees). This, and several other "intermediate" races, have been found in New Brunswick at 11 locations since 1978, but none later than 1981. The disease had been eradicated at 3 of the 11 locations even before the final race identifications were available. "Controlled" status has been achieved by the pruning of branches to 2 m from the ground at two locations, one in 1985 and one in 1987. In 1988, two more plantations in northeastern New Brunswick were brought under "control" by pruning (locations 1 and 3; c.f. 1987 annual report), the work being done by the Department of Natural Resources. The remaining four locations are "under surveillance", in that an annual inspection is conducted for symptoms and changes in symptom expression. Where present, branches with symptoms are cultured and tested to determine the appropriate race of the fungus. *Gremmeniella abietina* has been isolated from samples at three of these four locations in 1988. Results of race determination are not yet available, but no non-North American race of the fungus has been found at any of these locations since 1981. A detailed discussion

of this disease in the past 10 years has been provided in the 1987 annual FIDS report (Magasi, 1988).

SPRUCE BUDMOTHS

Spruce budmoths on white spruce comprise a group of closely related species: the spruce budmoth, *Zeiraphera canadensis* Mutuura and Freeman, the purple-striped shootmoth, *Zeiraphera unfortunana* Powell, and the lesser yellow shootworm, *Zeiraphera fortunana* (Kft.). Generally, *Z. canadensis* is the most common and most important of the three but occasionally the species-mix changes in favor of one of the other two. They have been omnipresent forest pests in the Maritimes since at least the late 1930s, when the Forest Insect and Disease Survey started to keep records. Although widespread, insect populations have generally been low, except for the occasional flare-up, usually on open-grown white spruce. The last recorded outbreak occurred in New Brunswick in the mid-1960s when spruce in parts of the Southwest Miramichi and the Nashwaak River drainage system sustained moderate to severe defoliation, and in Nova Scotia in the mid-1970s when similar levels of defoliation occurred in areas along the Northumberland Strait and the Fundy Coast.

Spruce budmoth, a not-too-important forest insect in mature forests, became a major pest in 1980, when it was discovered to be causing defoliation, shoot distortion, and tree deformation in white spruce plantations over large areas in New Brunswick. In 1982, over two-thirds of the 180 locations surveyed in the Region were infested by spruce budmoth. At over 40% of these locations, in both New Brunswick and Prince Edward Island, defoliation and shoot damage were in excess of 10%. Injury was classed as moderate or severe at 10 and 20%, respectively, at the locations surveyed.

In 1988, spruce budmoths were widespread in white spruce plantations in the Region and considerable shoot damage occurred in some areas.

In New Brunswick, an average of 10% of the shoots of white spruce trees were affected at locations scattered around the Province. Although the average was the same as last year, considerable shoot damage occurred at some locations. The greatest amount of damage was recorded at St. Luc, Kent County, where 49% of the shoots were affected. Other areas with more than 20% shoot damage were at Guitar, Gloucester County (43%), Mt. Conacher, Restigouche County (31%, by *Zeiraphera* sp.), South Portage, York County (24%) and Prince Settlement, Northumberland County (23%). Populations were lowest in some parts of Charlotte County.

In Nova Scotia, the insect was more common and the average shoot damage on white spruce increased to 12% from the 9% recorded last year. The most serious damage was observed at Mount Hanley, Annapolis County, where 71% of the shoots were affected and 63% shoot damage was recorded at Mount Denson, Hants County.

In Prince Edward Island, shoot damage occurred throughout the Province on open grown white spruce but an average of only 7% of the shoots were affected, compared to 15% observed last year. Local populations varied considerably, with the greatest amount of damage recorded at Auburn, Queens County, where 13% of the shoots were damaged and 80% of the trees were affected.

Control - In the fourth year of a developmental program towards control of the spruce budmoths, J.D. Irving Ltd., in cooperation with Forestry Canada - Maritimes, treated 9 400 ha of white spruce plantations with a single application of fenitrothion (Sumithion®) in northwestern New Brunswick. The chemical was applied at 105 g/ha in a total mix of 0.42 l/ha per application (a UULV formulation). Treatment was timed to coincide with adult emergence and results confirmed findings of previous years that, when applied at suitable timing, enough adult moths are killed to impact on egg laying and significantly reduce damage the following year. Pheromones were used again in 1988: to time spraying operations, to monitor population levels, and in mating disruption experiments (second year of a 3-year study).

SEEDLING DEBARKING WEEVIL

The seedling debarking weevil, *Hylobius congener* D.T., Sch. & Marsh., has been a significant cause of mortality of newly planted coniferous seedlings in central Nova Scotia since the early 1980s. The problem was first reported in 1984, when seedling mortality exceeded 85% in some plantations. The insect is present on sites as early as the time of harvest. Debarking of the stems of seedlings occurs from spring through to fall, resulting in progressively increasing seedling mortality. The

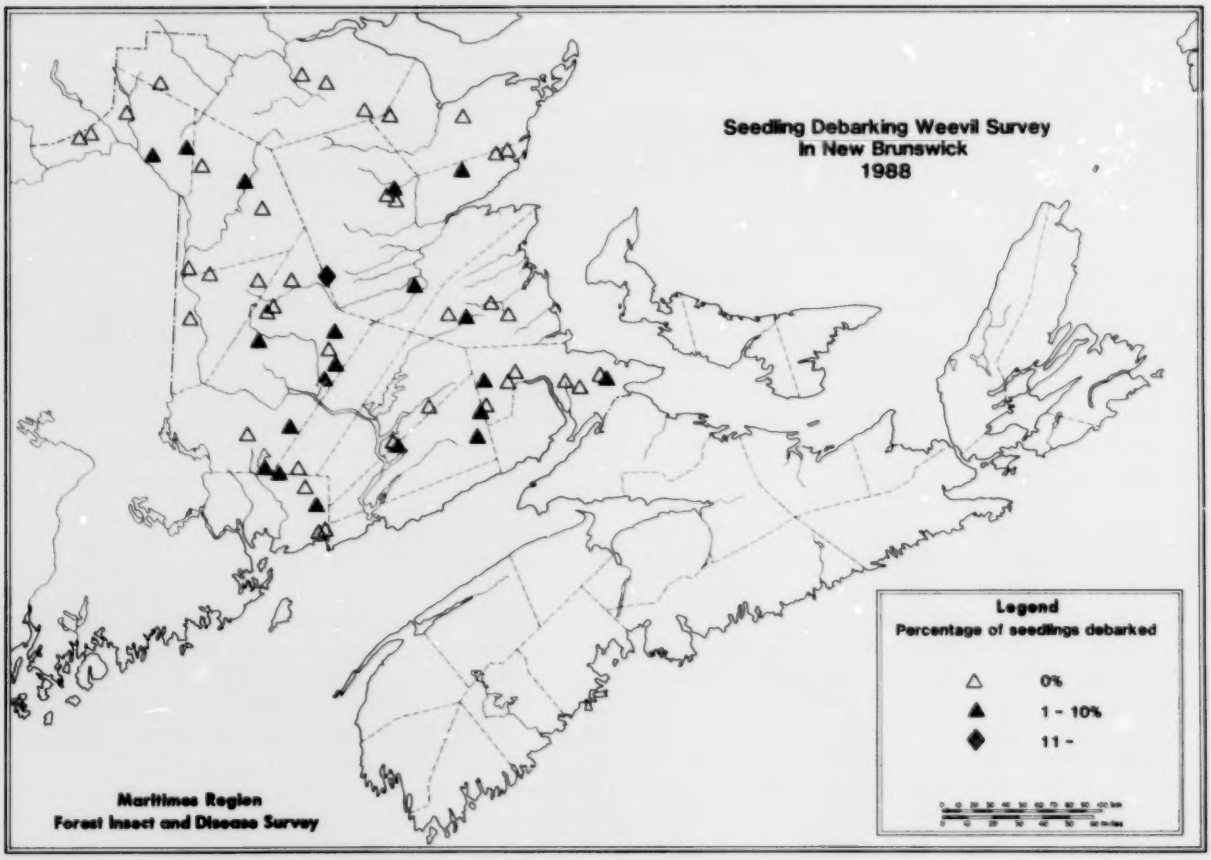


Figure 3

amount of damage is related to forest management practices, such as 'hot planting' (i.e. the reforesting of cutover areas very soon after harvest), site preparation, plantation size, and the proximity of plantations to other harvested areas. The level of concern for this insect is related to increased awareness by forest managers, the recognition of the fact that some unexplained plantation failures in the past may have been the result of weevil damage, and the realization that, in the absence of practical control methods, the future of large scale plantation programs may be jeopardized.

In 1988, the seedling debarking weevil continued to damage seedlings in newly planted sites, especially those which had been logged no longer than two years prior to reforestation. However, in recent years, forest managers in Nova Scotia and Prince Edward Island have taken steps to avoid losses, which have been as high as 90%. In Nova Scotia, sites have been evaluated for hazard from the weevil and dropped from planting plans for two or more years if the hazard rating was high. The principal criteria used to judge hazard has been a high content of conifers in the former cover type. In Prince Edward Island, control has been attempted by site preparation with anchor chains to disturb the litter and humus layers of the soil thereby exposing mineral soil which deters the weevil.

An extensive survey was conducted throughout the Maritimes during the fall of 1988 to describe damage and collect information which would improve hazard forecasting in potential reforestation sites. In Nova Scotia and Prince Edward Island, the survey was conducted under contract with funding from their respective Federal-Provincial Forest Renewal Agreements. The survey in New Brunswick was conducted by the Forest Insect and Disease Survey (Fig. 3). Information is not yet fully analyzed but the following preliminary observations provide the general situation. The three Maritime

provinces contrast dramatically in damage suffered by the weevil. At least some damage occurred in 30% of 60 plantations surveyed in New Brunswick, 100% of 70 plantations in Nova Scotia and 61% of 51 plantations in Prince Edward Island. The percentage of sites where more than 5% seedling mortality was recorded was: 5% in New Brunswick, 49% in Nova Scotia and 4% in Prince Edward Island. It is presumed that mortality would have been much higher in Nova Scotia had not a great many of the high hazard sites been removed from reforestation plans. It is suspected that in Prince Edward Island a considerable number of seedlings were saved by the use of site preparation control-tactics. A full analysis of the data regarding the microsite in which each seedling was planted will likely provide the explanation.

Tests of various control options, including site preparation and physical barriers continued during 1988 at five Nova Scotia sites. Research to develop a chemical control option continued at the Forest Pest Management Institute, Sault Ste. Marie, in cooperation with the Forest Insect and Disease Survey.

Two contracts to the Research and Productivity Council of New Brunswick supported by the Canada/Nova Scotia Forest Renewal Agreement, examined the life history of the seedling debarking weevil and the calibration of a trap-monitoring system under differing hazard levels.

Reports regarding the various research aspects of the seedling debarking weevil problem are expected to be available in 1989.

ARMILLARIA ROOT ROT

Armillaria root rot, *Armillaria mellea* (Vahl ex Fr.) Kummer, a disease of a wide variety of tree species of various ages, has always been a part of the forest disease complex in the Maritimes; however, its significance appears to have changed in recent years. On the one hand, the fungus is strongly implicated among the group of secondary organisms that combine to provide the final blow to trees weakened by other factors such as repeated defoliation by the spruce budworm. On the other hand, Armillaria infected or killed trees are becoming more frequent throughout the Maritimes, and are often observed in plantations. The increased frequency is doubtless a factor of the increase in the area planted. The implications of the root rot to the future of plantations under our climate are poorly understood. However, the disease is killing trees in plantations. In some areas, groups of trees are affected and there is evidence that with the spread of the fungus these patches could increase in size. In other areas, only scattered trees are infected but these could become centers of infection if the fungus spreads. Not all infected trees die, (the fungus is primarily a wood decay organism causing root and butt rot), but its action may cause understocking in both plantations and natural stands.

Armillaria root rot is also an important part of the complex organisms associated with mortality of mature trees that have been stressed by other factors such as repeated moderate or severe defoliation by the spruce budworm. The fungus is also closely associated with Stillwell's Syndrome, the sudden death of balsam fir trees.

The disease is widely distributed in the Region and mortality of trees, both young and old, was again common in 1988.

In New Brunswick, Armillaria root rot killed at least some trees in 16% of the 181 spruce and pine plantations surveyed (Table 1). The 16% incidence of Armillaria infected plantations is lower than the 22% incidence found in 1987 but is the same as the level determined in 1986. Infection rates are generally low, mostly in the 2% to 8% range, but reach as high as 36% of trees dead or dying in an eight-year-old black spruce plantation at Hunters Brook, Madawaska County. Armillaria root rot also caused tree mortality in other forest situations. Mature and semi-mature balsam fir, black spruce, red spruce and jack pine trees died in a number of areas in

Table 1. Armillaria root rot in spruce and pine plantations in New Brunswick and Nova Scotia in 1988

Plantations/ Infection	Host	New Brunswick	Nova Scotia
No. of plantations assessed	Spruce	131	37
	Pine	50	22
Percent of infected plantations	Spruce	18	11
	Pine	12	5

Table 2. Armillaria root rot - spread of disease in plantations 1983-1988

Species	Year planted	Year plot est.	Former cover type	Mortality (%)					
				1983	1984	1985	1986	1987	1988
Black spruce	1976	1983	Softwood	8	10	10	10	-	-
Black spruce	1973	1983	Softwood Hardwood	4	4	4	4	-	-
Black spruce	1978	1983	Softwood Hardwood	8	12	20	20	-	-
Black spruce	1980	1983	Softwood Hardwood	8	16	24	24	24	26
Jack pine	1978	1984	Softwood Hardwood	-	2	2	2	-	-
Jack pine	1981	1984	Softwood Hardwood	-	2	4	4	6	8
Jack pine	1978	1984	Softwood Hardwood	-	2	2	2	-	-
Black spruce	1980	1985	Softwood Hardwood	-	-	2	2	4	4

Victoria, Sunbury, Northumberland, Westmorland and Kent counties. Mortality was as high as 24% in a mature balsam fir stand at Shaw Brook, Westmorland County. A few lodgepole pine trees were killed in a nursery in Carleton County, the disease was present in three black spruce seed orchards, and balsam fir Christmas trees died at Blacklands, Restigouche County.

In Nova Scotia, Armillaria root rot killed at least some trees in 8.5% of the 59 spruce and pine plantations surveyed (Table 1). The damage level was generally low, the highest incidence recorded was 5% tree mortality in a red spruce plantation north of Upper Mount Thom, Pictou County. Diseased trees were also found in two black spruce seed orchards. Tree mortality in natural stands occurred at scattered locations throughout the Province but mortality levels were usually less than 3% in stands of red spruce, red pine, balsam fir, white pine and larch.

In Prince Edward Island, Armillaria root rot was found in a black spruce plantation of approximately 10 ha, south of Hermonville, Kings County, where about 5% of the trees were affected.

Plots established in plantations to study the spread of the disease on different hosts and under different conditions have been assessed annually since 1983. The plantations are of different ages and were established in areas of somewhat different cover types. The summary of observations is presented in Table 2. Only the three youngest plots were assessed in 1988 and some intensification was observed in two of the three plots. Trees in older plantations are said to acquire some resistance to fatal attack by Armillaria root rot, which they retain as long as they are in a vigorous condition without significant stress. Some of our study plantations are reaching this age. These plots will be observed annually but, unless conditions change significantly, they will be assessed only on a 5-year cycle. More

plots of various species and especially of younger ages need to be established to assess the real significance of this disease in plantations.

SIROCOCCUS SHOOT BLIGHT

Sirococcus shoot blight, caused by the fungus *Sirococcus conigenus* (DC) P. Cannon & Minter (previously known as *Sirococcus strobilinus* Preuss), has been known in the Maritimes since the early 1970s but has been present for much longer. The fungus infects and kills newly developed shoots. Fruiting bodies are produced on the twigs, needles, and cone scales, from whence spores disperse and cause new infections. Heavy attacks cause branch mortality, which results in crown dieback and tree mortality. In the Maritimes, the disease affects red pine and occasionally spruce and larch, although other species of pine, hemlock, Douglas fir, and true firs can also be affected. Trees of any size, from seedlings to 15 m in height, are damaged or killed. The initial infection in newly established plantations appears to be closely related to the proximity of older red pine stands, as 48% of young plantations less than 1 km from older red pine were found infected, compared to 8.7% which were more than 1 km away from an infection source. After the initial infection, the severity of the disease increases as the trees become older.

The disease is present in all three provinces but is most widely distributed in red pine plantations in Nova Scotia, west of the Colchester-Pictou and Halifax-Guysborough county lines, and in natural regeneration in the southern half of New Brunswick.

In 1988, the disease further intensified in all three provinces. In many areas, the repeated infection has resulted in serious deterioration of red pine stands and plantations; in some, to the extent that salvage operations were carried out.

In New Brunswick, Sirococcus shoot blight occurs mostly in the southern part of the Province, although affected plantations are known as far north as the line from southern Victoria to northern Kent counties. In 1988, the disease was found in a natural mixed stand at Crooked Depot, approximately 22 km southeast of Robinsonville, Restigouche County. Many semi-mature and mature red pine trees are affected in this stand, which is some 90 km further north than previously reported infections. In the south, deterioration of trees in previously infected areas continued: 75% of mature and semi-mature trees died in a 2 ha plantation in the Mechanic Settlement area in Albert County; nearly all red pine trees are affected in a 50 ha plantation, established in the early 1980s at McDougall Lake, Charlotte County where scattered, infected wolf trees were left; diseased trees were observed in several areas of Fundy National Park; in the Shin Creek area in Sunbury County; and a new infection was found at Big Forks along the Salmon River in Kent County.

In Nova Scotia, infected red pine stands in Colchester, Cumberland, Hants, Queens, Shelburne and Yarmouth counties continued to deteriorate, especially at Debert, Colchester County, at Diligent River, and Chignecto Game Sanctuary in Cumberland County, in the Stanley Management area, Hants County and in the Kedge River Management area, Queens County. Some plantations were salvage cut in 1987; others, in the Rushy Lake area, Yarmouth County, were cut in 1988. Newly infected plantations were found in areas of Cumberland, Lunenburg, and Shelburne counties, and white spruce trees were infected in a clonal seed orchard in Colchester County.

In eastern Nova Scotia, the disease reappeared in the Perch Lake road area, Pictou County, where it was present in 1985 and 1986. The trees were cut in an effort to curb the spread of the disease but were not destroyed, thus an infection source likely remained. Newly infected trees were also found 4 km southwest of this area in a red pine plantation along the Cox Brook Road, and northwest of Lorne Station, Pictou County.

Sirococcus infected white spruce cones were found in the Province at 13 of the 17 locations where cones were collected for reforestation programs. An average of 22% of the cones were infected and incidence level ranged from 3% to 73% at the affected locations.

The deterioration of pine stands caused by this disease in western Nova Scotia and the spread of the disease to plantations in the eastern half of the Province, where red pine has been a major plantation species in recent years, makes Sirococcus shoot blight one of the major plantation problems in Nova Scotia.

In Prince Edward Island, the disease is present at scattered locations including Goose River, Kings County, Iona and Selkirk Road, Queens County where it has been under observation for some years.

At Iona, where it was first reported on a few red pine trees in a 1 ha plantation in 1984, the number of infected shoots per tree has increased from "light" to about 60% on some of the fringe trees in 1986. Further intensification was noted in 1988. At Goose River, there was again a marked increase in shoot infection in a 3 ha, 23-year-old red pine plantation. First reported as light on a few trees in 1985, examination in 1986 showed that virtually all trees have some degree of damage with about 5% of fringe and open growing trees supporting close to 50% shoot damage. There was no change at Selkirk Road, where the disease was observed for the first time in 1986, and about 1-2% of the red pine supported from 5-29% damaged shoots on lower crown branches. In addition to the above, diseased red pine trees were present near Murray River, Kings County and a few spruce shoots were found infected in a hedgerow in the Georgetown-Royalty area of Kings County.

Control - Prompted by concern over the fate of red pine plantations, silvicultural control (pruning) experiments were carried out in Nova Scotia during the fall of 1988 under the aegis of Forestry Canada. Results will not be available until at least 1989.

PINE LEAF ADELGID

Pine leaf adelgid, *Pineus pinifoliae* (Fitch), requires two coniferous hosts for the completion of its complicated life cycle, during which one sexual and several asexual (parthenogenetic) forms develop. The adelgid alternates between red or black spruce and pine (mostly white pine). On spruce, conspicuous galls are formed, which can resemble cones. Even at high population levels little damage is caused to the tree. On white pine, the adelgid attacks new shoots and causes shoot mortality. When shoot damage is serious, the affected trees die. Attacks on white pine characteristically occur in alternating years in the Maritimes although the full effect of infestations may not be apparent until the following spring when dead shoots become conspicuous.

Pine leaf adelgid is present throughout the Maritimes. From 1942 until the mid-1960s, it often occurred at damaging levels, especially in southern New Brunswick and in Shelburne, Lunenburg and Queens counties on the south shore of western Nova Scotia. Populations were generally low and damage was minimal from the mid-1960s to the mid-1980s. There was a drastic increase of pine leaf adelgid populations in parts of western Nova Scotia in 1987, especially on white pine. In the early part of the summer, there were some areas where it was difficult to find white pine needles without at least a few adult female adelgids, having just arrived from nearby spruce trees, sitting at the tips of the needles.

Surveys conducted in Nova Scotia in 1987 showed the highest infestations to exist in Queens, Shelburne, Lunenburg and southern Annapolis counties, and that an average of 51% of the white pine shoots were infested. Some shoot mortality (6.3%) occurred by the fall, but most of the damage was expected to become evident by the spring of 1988.

In 1988, white pine shoot mortality was evident throughout much of Nova Scotia (Fig. 4) and averaged 21% at the 104 locations assessed. Damage was severe in 1% of the areas, moderate in 21%, light in 56%, trace in 21%, and no damage occurred in only 1% of the areas. Most of the heavy damage was again found in Queens, Shelburne, Lunenburg, Annapolis and Digby counties. The highest level of damage was recorded South of Blockhouse, Lunenburg County, where 76% of the shoots were dead and 68% shoot mortality occurred near Peskowesk Lake in Kejimkujik National Park, Queens County. On red spruce, new gall formation averaged 3% (range 0-13%) at the 48 locations surveyed, much reduced from the average of 23% found in 1987.

Pine leaf adelgid populations were very low in New Brunswick, a few adults having been found at only two locations, and none were observed in Prince Edward Island.

BALSAM WOOLLY ADELGID

The balsam woolly adelgid, *Adelges piceae* (Ratz.), previously known as the balsam woolly aphid, was introduced from Europe to North America in Nova Scotia about 1900, probably on nursery stock. It became established throughout Nova Scotia, Prince Edward Island, and the southern half of New Brunswick and at scattered locations throughout much of the remainder of the Province.

This insect attacks balsam fir and feeds on the thin-walled living cells under the bark. In feeding, it introduces a salivary substance into the tissue

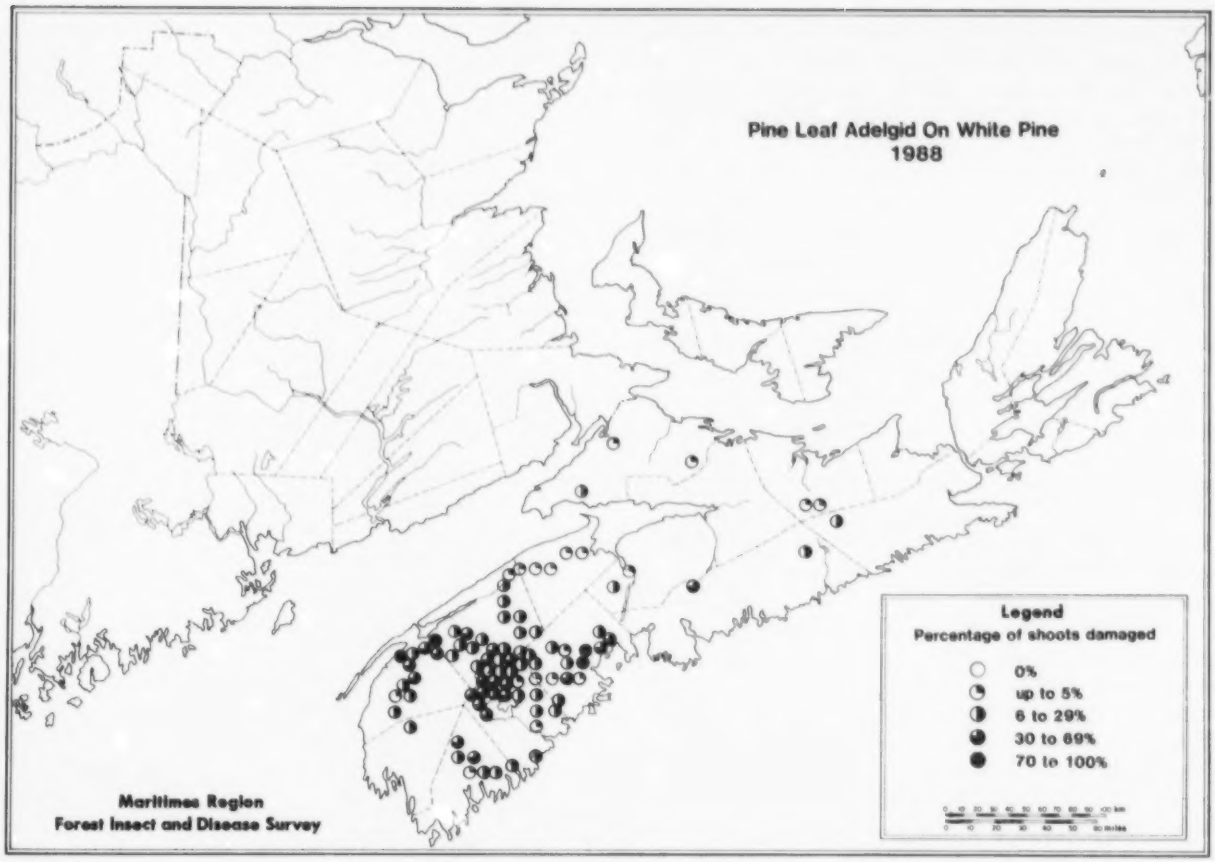


Figure 4

causing an abnormal multiplication of cells. Both twigs and stems are attacked. When twigs are attacked they become thickened and stubby, a condition called "gouting". On the trunk or stem, the sapwood beneath infested bark becomes brown and brittle. Many trees in a heavily infested stand die within one season. Infestation is indicated by the presence of a white woolly substance, secreted by the adelgid. At high populations, the stems of affected trees may be completely white.

Attacks by the insect have persisted in parts of the Region for many years, with twig attack being the usual expression in coastal areas and stem attack in inland locations. Losses, in terms of tree growth, mortality, and decreased wood quality, have been substantial. Infestations, particularly in inland New Brunswick, have been much reduced since the mid-1960s as a result of low winter temperatures and death of host trees, killed by the spruce budworm. However, chronic twig attack has persisted in parts of Nova Scotia and Prince Edward Island even though stem attacks have been rare.

In New Brunswick, an increase in stem attack has been noted in the last few years at scattered locations and, although populations are generally light, there are indications that the adelgid is again becoming more common. In 1988, 68% of the trees had light stem attack at Tynemouth Creek, St. John County, and 40% of the trees had light stem wool along Maidenhead Road in the Oromocto-Base Gagetown area, Sunbury County. Gout and twig attack were moderate (42%) on 60% of the trees at Tynemouth Creek, St. John County. Various levels of twig attack were present on balsam fir in several other areas of St. John County. Some Christmas trees sold in the Fredericton area also exhibited gouty twigs.

In Nova Scotia, balsam woolly adelgid populations remained relatively stable. Most of the damage

occurred in the form of twig attack, which was largely restricted to coastal areas, especially in Guysborough and Halifax counties. The highest level of twig attack was recorded at Harperville, Guysborough County where 72% of the balsam fir trees were affected, and at Odgen, Guysborough County, where at least some gouty twigs were observed on 64% of the trees.

In Prince Edward Island, the balsam woolly adelgid was not observed in 1988.

RUSTS ON NEEDLES, LEAVES AND CONES

Needles of conifers are infected by a group of rust fungi. They cause the infected needles to fall off the tree prematurely and, when infection levels are high, damage occurs, such as reduced grade for Christmas trees, growth loss or, in cases of repeated severe defoliation, death of young trees in plantations.

Most of the rust fungi need two different hosts to complete their life cycle. The alternate host is often a herbaceous or woody plant which occurs in close association with the coniferous host, frequently in the same plantation. The various species of rusts on the conifers are very similar in appearance but, because each species needs a different alternate host, the proper identification of the fungus is important if control measures are anticipated.

On hardwoods, the situation is similar to that on conifers. Heavy infection causes foliage discoloration and the leaves fall prematurely. Repeated heavy attacks result in twig and branch dieback and may eventually kill the tree. Many of the leaf rusts, such as those found on poplars and willows, are stages of the same species alternating between these trees and various conifers. Control in these situations, where both hosts are of value, becomes complicated. For example, care must be taken in species selection for use such as in windbreaks around nurseries, seed orchards or ornamental settings.

The various rusts encountered in 1988 are discussed by host tree species below:

Coniferous hosts:

On Balsam fir - Needle rusts found on balsam fir in 1988 included *Melampsora abieti-capraearum* Tub. (alternate host: willow), *Pucciniastrum epilobii* Otth (alternate host: fireweed), and *Uredinopsis sp.* (alternate hosts: ferns). They were present throughout the Region but infections were generally very low and nowhere exceeded 5% of the needles affected.

On Hemlock - *Pucciniastrum vaccinii* (Wint.) Jorst. (alternate host: cranberry, blueberry) was found in only one area of Nova Scotia and infection was only 2%.

On Larch - *Melampsora medusae* Thuem. (alternate host: poplar) was found in two seed orchards, at Porten Settlement, and at Queensbury, York County, and in a natural stand in Kent County in New Brunswick where it caused light needle infection. Trace level of infection was observed at a few other locations in New Brunswick and in two areas of Nova Scotia.

On Pine - *Coleosporium asterum* (Diet.) Syd. (alternate host: goldenrod) and *Coleosporium viburni* Arth. (alternate host: Viburnum sp., wild raisin, hobblebush, highbush cranberry, etc.) were the two species of needle rusts encountered on pine in 1988. While *C. viburni* appears mostly on jack pine, *C. asterum* affects both jack pine and red pine and the two species may occur together when their respective alternate hosts are present.

C. viburni has been by far the most important needle rust encountered in recent years in New Brunswick. Repeated severe infection and the needle drop that follows resulted in young jack pine plantation trees being sustained only by their current foliage in a number of areas in the southern half of the Province until 1985. Infection levels have declined sharply since 1986, although severe infection still occurs in a few plantations. In 1988, 80% of the jack pine trees were severely infected in a young plantation at Belleford, Northumberland County. In Nova Scotia, infected jack pine trees were found in only one plantation, in Guysborough County, but only 2% of the needles were affected. In Prince Edward Island, the rust was not observed in 1988.

Coleosporium asterum (Diet.) Syd. (alternate host: goldenrod) was found in a few scattered red pine and jack pine plantations in the Maritimes. The highest level of infection on red pine occurred at Greenfield, Colchester County, Nova Scotia where 33% of the older needles were infected; and on jack pine in a 5-ha plantation at Goose River, Kings County, Prince Edward Island, where the infection rate was 15%.

On Spruce - *Chrysomyxa ledi* (dBy.) and *Chrysomyxa ledicola* Lagerb. (alternate host for both: Labrador tea) were present but at very low levels on black spruce, white spruce, and red spruce at scattered locations throughout the Region. The highest infection level was recorded on white spruce at French Lake, Inverness County, Nova Scotia, where 9% of the needles were infected by *C. ledi* and 9% of the cones were affected by *C. ledicola*.

The cone rusts *Chrysomyxa pirolata* Wint. and *Pucciniastrum americanum* (Farl.) Arth. were both common in 1988, probably as a result of the heavy spruce cone crop throughout much of the Maritimes. *C. pirolata*, a systemic rust which completely destroys infected cones, was found in 23% of red spruce cones at Lansdowne, Digby County, Nova Scotia and was found at low levels in seed orchards throughout the Region. *P. americanum*, a rust which infects cone scales and causes seed loss only when infection is severe, was common in Nova Scotia on white spruce but caused serious damage only at Kathy Road, Cape Breton Highlands, where all cones were infected and 36% were destroyed by multiple infection. The rust was present on 28% of cones collected from a single white spruce tree at Stanhope, Queens County, Prince Edward Island.

Hardwood hosts:

On Ash - The ash rust, *Puccinia sparganioides* Ell. & Barth. (alternate host: cord grass (Spartina sp.)), has been one of the most serious foliage problems on ash in many parts of western Nova Scotia for the past decade. Infection causes foliage discoloration and premature leaf fall. Repeated attacks cause dieback and in some cases tree mortality.

In 1988, the chronic infection continued in many parts of Nova Scotia but, although severe infection occurred again in some areas, the level of infection was generally lower than in 1987. The average infection was 29% and the most seriously affected areas were in Annapolis, Digby, Hants, Kings, and Yarmouth counties. The highest infection occurred west of Bear River, between Smith's Cove and Bear River, Digby County, where all leaves of all trees were affected. Severe damage was also noted on ornamental trees at Gavelton, Yarmouth County. Twig and branch mortality increased on repeatedly affected trees at Hantsport, Hants County and Clementsport, Annapolis County. Infection levels decreased to 48% at Hortonville, Kings County, where all foliage was affected in 1987, and was noticeably less than last year in Hantsport and Summerville, Hants County. In New Brunswick, no ash rust was found in the Norton area of Kings County, where severe infection was reported in 1987, and no ash rust was observed in Prince Edward Island.

On Oak - *Cronartium quercuum* (Berk.) Miyabe was found on leaves of red oak in a collection from Northumberland County, New Brunswick. This is the first time this fungus has been reported in the Maritimes and its discovery has implications for jack pine. Globose gall rust, a disease of pine, which causes swellings on branches and stems of young trees, has been attributed to the fungus *Endocronartium harknessii* in the past. *E. harknessii*, a microcyclic rust, does not have an alternate host and spreads directly from pine to pine. *C. quercuum*, also causes globose galls on pine, almost identical in appearance to those caused by *E. harknessii*. However, it alternates between pine and oak and cannot complete its life cycle without both hosts present. The implications are not clear but, in the future, the pine-oak association must be considered, especially in areas where both hosts are common.

On Trembling aspen - *Melampsora abietis-canadensis* C.A. Ludwig ex Arth. (alternate host: hemlock), infected 13% of leaves on 20% of the trembling aspen trees in an area of Cumberland County, Nova Scotia.

HEMLOCK LOOPER

Hemlock looper, *Lambdina fiscellaria fiscellaria* (Gn.), contrary to its name, is mainly a defoliator of balsam fir in the Maritimes, capable of causing serious damage when populations are high. It feeds on needles of all age classes and is a wasteful eater. Larvae chew off but do not consume all of the needles, consequently a much greater amount of foliage is removed than is necessary for their development.

In the Maritimes, populations have been generally low in the past few years. The last serious outbreak occurred in central Prince Edward Island in 1977 and 1978 when the insect killed 80% of the merchantable balsam fir and over 90% of the hemlock in the affected area.

In 1988, populations of hemlock looper were low throughout the Maritimes. In New Brunswick, only one larva was collected, from a balsam fir tree in York County. In Nova Scotia, only trace defoliation occurred in the Diligent River-Yorke Settlement area of Cumberland County in the stands where defoliation was moderate and severe in 1987 and where a small outbreak had persisted since 1985. In Prince Edward Island, light defoliation occurred on the surviving trees in a forested area near Iris, Kings County, where an outbreak prior to 1987 killed or severely damaged balsam fir and hemlock. Large hemlock and a few balsam fir trees are dying in an approximately 10 ha area north of Granville, Queens County, as a result of severe defoliation.

Light trap catches were somewhat higher than in 1987 in southern New Brunswick and in the two National Parks in Nova Scotia but much lower in all three traps in Prince Edward Island. Egg surveys in Nova Scotia, conducted by the Department of Lands and Forests, indicate generally low hemlock looper populations for 1989, in the province.

WHITEMARKED TUSSOCK MOTH

Whitemarked tussock moth, *Orgyia leucostigma* (J.E. Smith), is a defoliator of considerable economic importance. Larvae feed on a variety of coniferous and deciduous hosts. Outbreaks of this insect are usually short but severe, followed by a number of years of very low populations.

The last outbreak of whitemarked tussock moth in the Maritimes occurred in the early 1970s and collapsed by 1979, due mainly to a nuclear polyhedrosis virus. Populations were very low until 1984, when the first signs of a new build-up were observed. By 1985, the insect, although still at generally low populations, was common in most of mainland Nova Scotia and in southern New Brunswick. In 1986, whitemarked tussock moth was present in many areas in the Region but caused noticeable defoliation only in eastern mainland Nova Scotia. Defoliation, at various levels of intensity, was somewhat patchy depending on forest cover type. Affected host species included white birch, red maple, apple, larch, and balsam fir. However, diseased larvae were present at a number of locations and, in 1987, populations collapsed before an outbreak developed. Also in 1987, whitemarked tussock moth caused light defoliation of white birch and red maple over an area of about 1 000 ha in northern Kings County in Prince Edward Island. Populations were low in New Brunswick and no defoliation was observed.

In 1988, in New Brunswick, populations in general appeared to be increasing over 1987 levels. Moderate defoliation of various hardwoods, including basswood, silver maple, elm, and willow, occurred along a 1 km stretch of the Trans Canada Highway west of Jemseg, Queens County; light defoliation was observed at Upper Tetagouche, Restigouche County; and either trace defoliation or a number of larvae were found in other areas of the Province.

In Nova Scotia, numerous larvae were observed but only trace defoliation of hardwoods and understory balsam fir occurred in the New France-Havelock area of Digby County. A few egg masses were present throughout the province in the fall, being more numerous in Digby, Annapolis, Lunenburg, Halifax, and Cumberland counties. Light-trap catches more than tripled (from 20 to 66 moths caught) in Kejimkujik National Park and reached the highest number since the 1975-1978 outbreak in that part of the Province.

In Prince Edward Island, light defoliation of hardwoods occurred again in the Hermanville area of Kings County where birch and maple were affected in 1987. Elsewhere in the Province whitemarked tussock moth severely defoliated an apple tree in the Cavendish campsite in Prince Edward Island National Park.

GYPSY MOTH

After its reappearance in the Maritimes in 1981, the gypsy moth, *Lymantria dispar* (L.), gained further ground in 1988. The gypsy moth appears to be established in both New Brunswick and Nova Scotia and caused visible defoliation in the Region for the first time in nearly half a century in 1987.

Gypsy moth has been the most destructive insect of hardwoods and, to a lesser degree, of conifers in the northeastern United States for decades. However, the area affected by defoliation has been declining sharply in recent years. The status of the outbreak in Maine has been of special concern to us because of its proximity to our Region. In 1988, gypsy moth populations in Maine were low and only some 40 ha of gypsy moth defoliation was recorded.

In the Maritimes, the gypsy moth monitoring committee remained active in 1988, and again coordinated all surveys. This committee was formed in response to the discovery of gypsy moth in 1981, in an effort to utilize available manpower more efficiently in combatting this latest threat to the forests of the Region. Organizations involved in surveys included Forestry Canada, Parks Canada of Environment Canada, the Plant Health and Inspection Branch of Agriculture Canada, New Brunswick Department of Natural Resources, New Brunswick Department of Agriculture, New Brunswick Department of Tourism, Recreation and Heritage, Nova Scotia Department of Lands and Forests, Nova Scotia Department of Agriculture, Prince Edward Island Department of Energy and Forestry, and numerous municipalities. Many volunteers, campground operators, small woodlot owners, Christmas tree growers, students, and other interested private citizens also assisted in the pheromone trapping program.

In 1988, early season egg-mass surveys, larval surveys, late-fall egg mass surveys, and an adult trapping program were conducted to determine the current status of the insect in the Region.

The adult male trapping program is aimed at defining areas where searching for egg masses should be concentrated. As a result of studies since 1980, the trap placement design was changed in 1983 to eliminate, or at least to minimize, interference from large numbers of male moths brought into the Region by weather fronts from infested areas in the United States. 'Survey' traps are now placed in late July. The date was not changed for trap placement for control purposes and control traps are still placed at the beginning of July. Information was obtained from 5871 traps in the Region, 2290 in New Brunswick, 3297 in Nova Scotia, and 284 in Prince Edward Island, representing a 93% trap return. The high return, because of better understanding by cooperators of the value of negative results, greatly aided the planning of the fall egg mass surveys.

The status of the gypsy moth in the Maritimes in 1988 was as follows:

In New Brunswick, gypsy moth egg masses and/or pupae were found during egg mass surveys at 10 locations (Fig. 5 and Table 3). Of these, only 3 locations are new, however, Scotch Ridge, Greenrock, and Indian Falls are all in the general area of other positive finds. The total number of areas where gypsy moth has been found at least once since 1981 is 47. However, only 8 of these areas are outside Charlotte County and, with the exception of Fredericton and Forest City, the gypsy moth has been found only once at any of these locations. In Saint John, an unemerged pupa was found in 1981 and the lack of any activity in this area since then indicates the introduction of a larvae rather than an egg mass. A similar situation is suspected in the area near Peel, Carleton County, where two years of extensive trapping and searching have failed to confirm the presence of gypsy moth.

Over 80% of the known gypsy moth locations in New Brunswick are in Charlotte County and all 10 areas where gypsy moth was found in 1988 are in the western half of the county or in areas adjacent to it in southwestern York County. In view of the above, the western half of Charlotte County of New Brunswick is considered to sustain a generally low level but widespread population of gypsy moth, both in forest and, at least in the case of St. Andrews, in urban settings. However, the 10 positive locations in 1988 represent less than 4% of the 252 areas searched for egg masses in Charlotte and southwestern York counties, and thus indicate low gypsy moth populations.

In Nova Scotia, gypsy moth was found at 13 locations (Fig. 5), in seven of the nine counties in the western half of the Province. All but one of the areas were either the same or adjacent to areas where the insect had been found in previous years. The exception was Bridgetown, Annapolis County, which represents a "fill-in" situation, a minor extension in distribution in the Annapolis Valley. Egg masses were not numerous in most areas except at New Minas and Annapolis Royal but even there noticeable defoliation did not occur in 1988. It is worth noting that gypsy moth was not found in several areas, most notably Yarmouth County, where egg masses were present in previous years, and that, with the exception of Bridgetown, all positive locations are the same as in 1987.

In Prince Edward Island, the gypsy moth is not known to occur to date. There were only seven male moths caught in the 284 pheromone traps in the Province. They were all single catches except one and no egg masses were found at any of these locations.

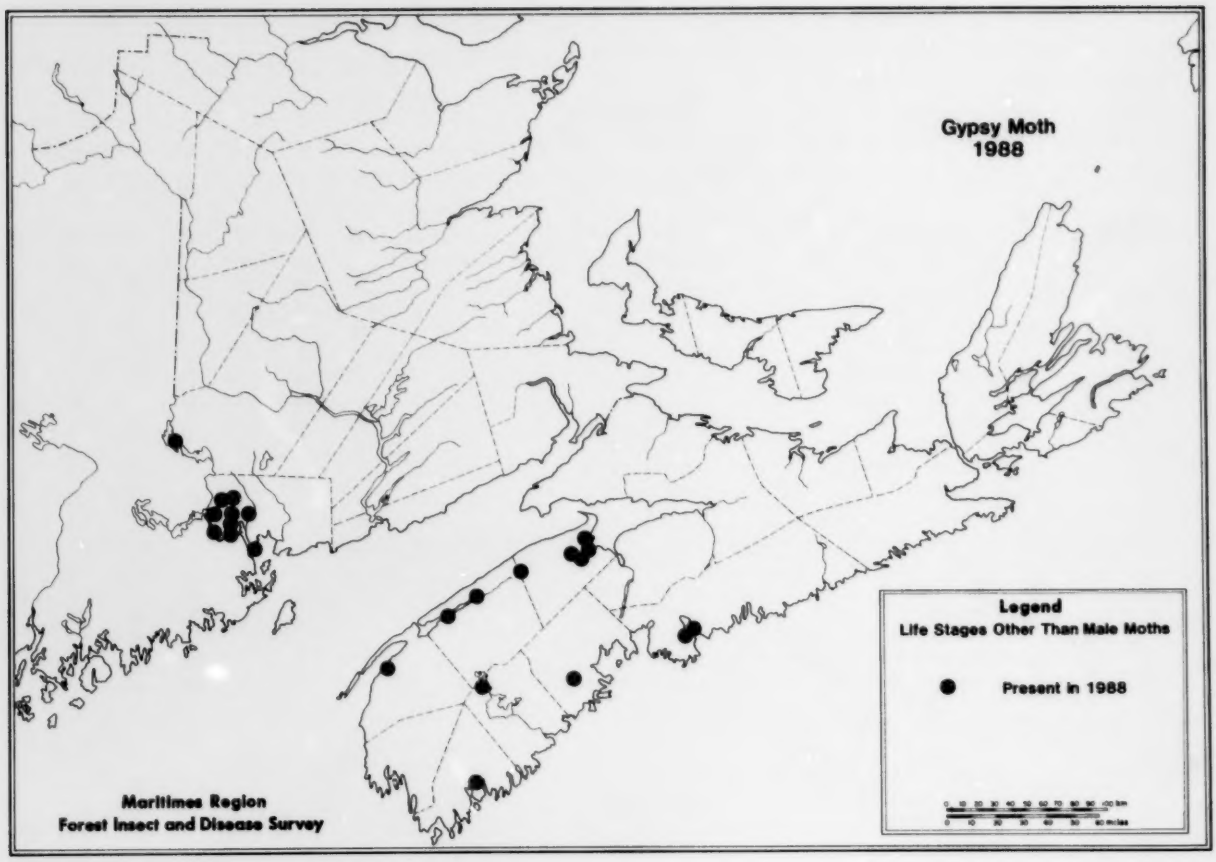


Figure 5

The results of gypsy moth surveys, other than adult trapping programs, conducted from 1981 to 1988 are summarized in Tables 3 and 4. In New Brunswick, most of the gypsy moth locations are in forested areas, away from habitation, and are concentrated in a small section of the province adjacent to an area of the United States where the insect is known to be present. In Nova Scotia, almost all of the infested spots are inhabited areas with considerable movement of people. This suggests that, while in New Brunswick, the presence of gypsy moth, in most places, may be the result of natural spread, in Nova Scotia the insect was likely imported by commercial traffic, visitors or residents travelling in gypsy moth infested areas.

Control operations against the gypsy moth in 1988 were conducted at a number of clearly defined locations. The lead agency listed below for the various programs carried the major responsibility, with assistance at various levels from other cooperating agencies. All pheromone traps were provided by Agriculture Canada.

Moores Mills, N.B. - In 1987, at the site of the first high intensity outbreak in the Maritimes in half a century, a cooperative effort to eradicate, or at least reduce, the population included cutting, then root-raking all vegetation on a 4-ha area, followed by an intensive trapout program, ground spraying, egg mass search-and-destroy operation and burning of the piled-up brush. This effort was followed in 1988 with: spring egg mass surveys; ground spraying with permethrin (Ambush 500 EC®) at a rate of 35 g/ha; aerial spraying of a 130 ha area, centering around last year's hot spot, with *B.t.* (Futura®, 30 BIU/ha, 3 applications); a trap-out program; and fall egg mass surveys.

Table 3. Summary of the results of detection surveys for gypsy moth in New Brunswick 1981 - 1988

County	Location	UTM Grid[1]	Gypsy moth life stages found[2]							
			1981	1982	1983	1984	1985	1986	1987	1988
Carleton	Peel	19-61-513					■	□	□	□
Charlotte	Mohannes	19-62-500	■	■	■	■	■	■	■	■
	N.W. of Oak Hill	19-62-502			■	■	□	□	■	□
	Oak Hill	19-63-502		■	■	■	■	■	□	■
	Upper Mills	19-63-499			■	□	□	□	□	□
	Lynnfield	19-63-502		■	□	□	□	■	□	□
	St. Stephen	19-63-500			■	■	■	□	□	■
	Oak Bay area	19-64-501			■	□	□	□	□	□
	St. Andrews	19-65-499			■	■	■	■	■	■
	Didgequash	19-66-500		■	□	□	□	□	■	□
	St. George	19-67-499		■	■	■	□	□	□	□
	Beaver Harbour	19-67-499	■	□	■	□	□	□	□	□
	Pennfield	19-68-499	■	□	□	□	□	□	□	□
	Campobello Island	19-66-497		■	□	□	□	□	□	□
	Grand Manan Island	19-67-494	■	□	□	□	□	□	□	□
	Burnt Hill	19-63-500				■	□	□	□	□
	Old Ridge	19-63-500					■	□	□	■
	Bayside	19-64-500					■	■	□	□
	Little Ridge	19-62-500					■	■	□	□
	Grand Falls Dam	19-61-501					■	□	□	□
	Basswood Ridge	19-62-501					■	■	□	□
	Moores Mills	19-63-501						■	■	■
	Pleasant Ridge N.W.	19-65-503						■	□	□
	Anderson Settlement	19-63-503						■	□	□
	Baillie Settlement	19-63-502						■	□	□
	W Moores Mills Lake	19-63-501							■	□
	S of Cranberry Lake	19-63-501							■	□
	Heathland	19-63-500							■	□
	SE of Scotch Ridge	19-62-501							■	□
	Mayfield	19-63-500							■	□
	Ledge Road	19-64-500							■	□
	S of Beaconfield	19-62-503							■	□
	N of Oak Hill	19-62-502							■	□
	NE of Scotch Ridge	19-62-501							■	□
	S Maxwell Crossing	19-63-500							■	□
	Rollingdam	19-65-501							■	□
	Oak Bay Prov. Park	19-64-500							■	□
	Scotch Ridge	19-62-501								■
	Greenrock	19-64-501								■
	Indian Pond	19-63-502								■
St. John	Saint John	19-72-501		■	□	□	□	□	□	□
York	Forest City	19-59-505					■	□	□	■
	Fredericton	19-68-509			■	■	■	■	□	□
	St. Croix	19-62-504					■	□	□	□
	McAdam	19-63-505						■	□	□
	Woukichegan Lake	19-62-505						■	□	□
	Beaverdam	19-67-507							■	□

[1]U.T.M. = Universal Transverse Mercator System;
[2]Life stages other than adults: ■ = Gypsy moth found; □ = Gypsy moth not found;

Table 4. Summary of the results of detection surveys for gypsy moth in Nova Scotia 1981 - 1988

County	Location	UTM Grid[1]	Gypsy moth life stages found[2]							
			1981	1982	1983	1984	1985	1986	1987	1988
Yarmouth	Yarmouth	20-24-485	■	■	■	□	■	□	□	□
	Tusket	20-26-486			■	■	■	□	□	□
Digby	Grosses Coques	20-25-491		■	■	□	□	□	□	□
	Digby	20-28-494			■	□	□	□	□	□
	Smiths Cove	20-28-494		■	□	□	□	□	□	□
	Weymouth	20-26-492				■	■	■	■	■
	Weymouth Falls & Tusket Road	20-26-492				■	■	□	□	□
	Bear River	20-28-493					■	□	□	□
Annapolis	Clementsport	20-29-494		■	□	■	■	□	□	□
	Paradise	20-32-497		■	■	□	□	□	□	□
	Middleton	20-33-497				■	■	□	□	□
	Bridgetown	20-31-496								■
	CFS Cornwallis	20-29-494						■	□	□
	Annapolis Royal	20-30-495					■	■	■	■
	Kejimkujik Nat. Pk	20-31-492			■	□	□	□	□	□
Queens	Kejimkujik Nat. Pk	20-32-491						■	■	■
Kings	New Minas	20-38-499			■	■	■	■	■	■
	Port Williams	20-38-499					■	■	■	■
	CFB Greenwood	20-34-498						■	■	■
	Canning	20-38-500							■	■
	Kentville	20-38-499							■	■
Halifax	Halifax	20-45-494			■	■	■	■	■	■
	Dartmouth	20-45-494				■	■	□	□	■
Shelburne	Shelburne	20-31-484			■	■	■	■	■	■
	CFB Shelburne	20-31-484						■	■	□
	Clyde River	20-30-483			■	□	□	□	□	□
Lunenburg	Bridgewater	20-37-491					■	■	■	■
Hants	Windsor	20-41-498					■	■	□	□

[1]U.T.M. Grid = Universal Transverse Mercator System;
[2]Life stages other than adults: ■ = Gypsy moth found; □ = Gypsy moth not found;

Table 5. Summary of gyspy moth trapout programs in Nova Scotia communities in 1988

Location	Traps returned	Traps recovery %	Positive traps	No. of moths caught	Egg masses in fall
New Minas-Kentville	1178	92	346	2430	Yes
Port Williams-Canning	188	94	84	734	Yes
Annapolis Royal	284	95	192	1648	Yes
Shelburne	400	86	133	319	Yes
Bridgewater	192	96	51	129	Yes

The larval population, following the *B.t.* spray, was reduced from a pre-spray value of 3.8 larvae/hour-search to a post-spray 0.2 larvae/hour-search. The adult male catch in the trap-out program in 1987 was 3322 males caught in 347 traps (9.6 moth/trap). In 1988, this was reduced to 32 moths caught in 305 traps, a mere 0.1 moth/trap. A few (2) fresh egg masses were found in the fall, indicating that, even though total eradication has not been achieved, the population was drastically reduced. Lead agency: New Brunswick Department of Natural Resources.

Mohannes, N.B - A 257 ha area, at the site of the first gypsy moth find in 1981, received 3 aerial applications of *B.t.* (Futura®; 30 BIU/ha) in 1988. In this area, in 1983, 18 ha were clearcut of oak, 102 ha were sprayed with *B.t.* and over 5 000 egg parasites (*Anastatus disparis*) were released. Extensive annual egg mass surveys since then served the dual purpose of removing egg masses and obtaining rearing material for parasite recovery rearing. The parasite has never been recovered from this or from neighbouring areas of Maine (thanks to the Maine Forest Service for their cooperation in this project). In the fall of 1988, one fresh egg mass was found in the Mohannes area. The 0.01 egg mass/hour search-ratio indicates very low populations. Lead agency: New Brunswick Department of Natural Resources.

Fredericton, N.B. - A trap-out program in a small area of the city where over two dozen egg masses were found in 1983, was repeated for a third year. The following information indicates that gypsy moth, if not eliminated, was reduced to sub-detectable levels in the trapout area (in 1985, the year before the program started, 15 egg masses were found in the trapout area):

1986 - 650 traps; 231 male moths; 4 egg masses
1987 - 572 traps; 9 male moths; 0 egg masses
1988 - 556 traps; 5 male moths; 0 egg masses

Lead agency: City of Fredericton, with advice from Forestry Canada - Maritimes.

St. Andrews, N.B. - After a few years of "heavy surveys", a trapout program was initiated in 1988 in the part of the town where egg masses were regularly found. Of the 595 traps placed, 564 were returned. No moths were caught in 329 of the traps but 478 moths were captured in the 235 positive traps. Egg masses (26) were found in the fall. Lead agency: Agriculture Canada, with cooperation from the town.

St. Stephen, N.B. - The trapout program involved the placement of 430 traps, of which 359 were returned. Sixty traps were negative but 1315 moths were caught in the 299 positive traps. Egg masses (16) were found in the fall. Lead agency: Agriculture Canada with cooperation from the town.

Nova Scotia - The results of trapout programs at a number of locations in the Province are summarized in Table 5. Only areas where at least 200 traps were placed are considered as a genuine effort at trapping out gypsy moth males. Locations with fewer than 200 traps are considered as "heavy survey", even though the male population reduction effect of these is recognized. For Shelburne this was the third year of the trapout program. About 500 moths were caught in 388 traps in 1987, similar to results obtained in 1986. Lead agency: Nova Scotia Department of Lands and Forests.

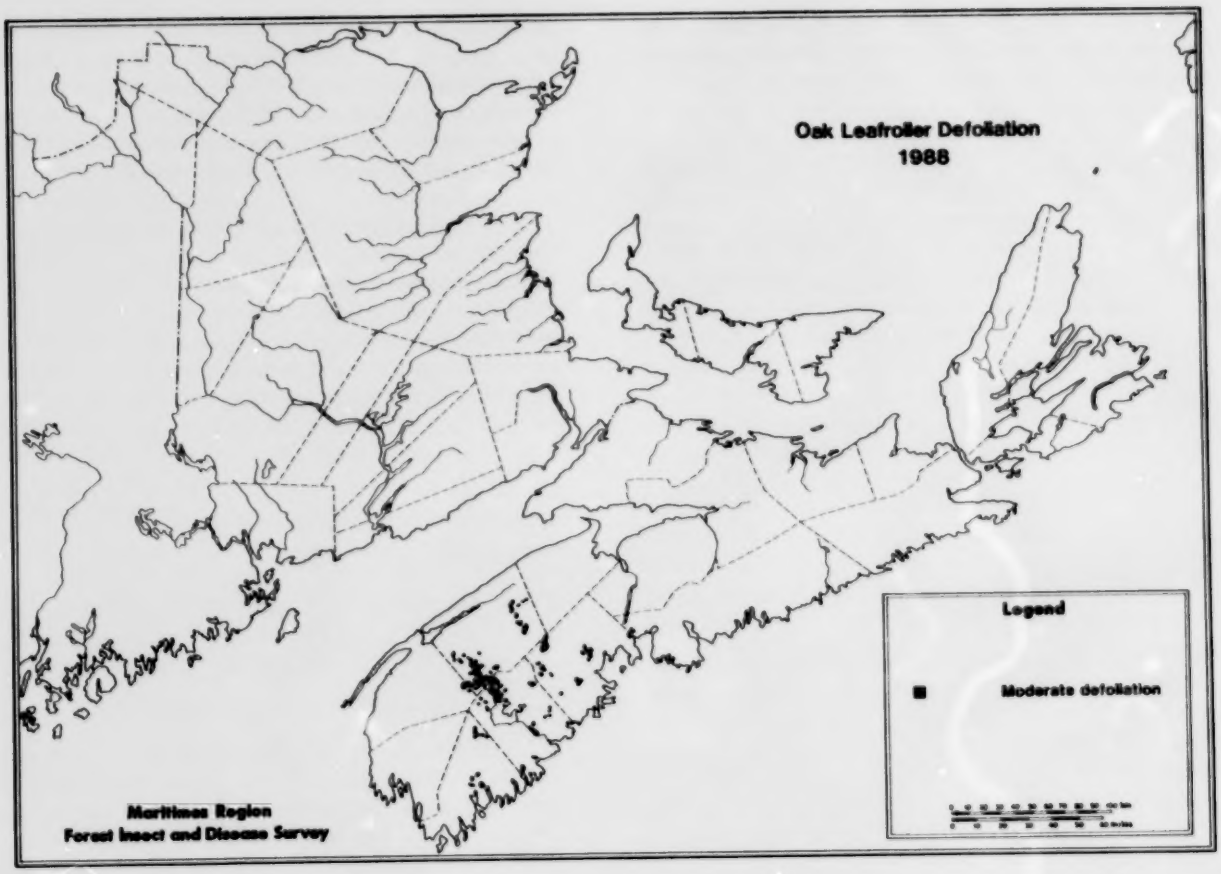


Figure 6

OAK LEAFROLLER AND OAK LEAF SHREDDER

Oak Leafroller, *Pseudexentera cressoniana* (Clem.), and the Oak Leaf Shredder, *Croesia semipurpurana* (Kft.), have been defoliating oak since the early 1970s and are the most serious pests of oak in the Maritimes. As a result of repeated defoliation, oak trees in many areas are suffering from various degrees of twig, branch, and crown dieback. Insect populations started declining in 1983 and the decline continued in 1984, but the insects still caused various amounts of defoliation of oak in 1985 throughout the Region. By 1986, only spot infestations remained in New Brunswick and Prince Edward Island but widespread defoliation occurred in western Nova Scotia. The situation remained the same in 1987.

In 1988, the insects, predominantly the oak leafroller, were present again in western Nova Scotia. Defoliation of red oak affected 22 800 ha and occurred in many stands in Annapolis, Lunenburg, Queens, and Shelburne counties (Fig. 6). The intensity of defoliation, which ranged from 3% to 100% at affected locations, averaged 69% overall, a 15% increase in average intensity from the 54% in 1987. The average defoliation of red oak at permanent observation plots was 54% (range 45 to 70%) in Lunenburg and Queens counties in 1988, an increase of 8% from the average in 1987. The most severe defoliation was observed in the Kejimkujik National Park, Annapolis County and at Colpton, Lunenburg County, where all the foliage of all the trees in the stands was severely damaged.

Red oak stands in western Nova Scotia are in a generally deteriorating condition. A survey of tree condition in 35 stands in 1988 found that at least some crown dieback is present in all red oak stands in Queens, Annapolis and Lunenburg counties and that at least some stands are affected in the other counties in this part of the Province. More than 5% of

the trees were dead and branch mortality was observed on almost 63% of the 931 trees examined (Table 6).

Table 6. Tree condition of red oak after repeated defoliation in western Nova Scotia, 1988

Tree condition classes		Percent of trees in class (a)
Healthy		9.1
Twig dieback only		22.6
Branch dieback	1-25%	42.9
	26-50%	14.3
	51- %	5.0
	dying	0.6
Dead		5.5

(a) Based on assessment of 931 trees.

These insects are causing serious damage in western Nova Scotia. They may also be creating an indirect problem because the widespread defoliation caused by them could conceivably delay the detection of early infestations of gypsy moth, a recently introduced insect in this part of the Province, of which oak is one of the most favored host species.

In New Brunswick, populations of the two insects remained low in 1988. The oak leafroller caused moderate defoliation of red oak in a part of Fredericton, York County, and light to moderate defoliation at Cranberry Lake, Queens County, in the area with the longest defoliation history during the current outbreak. Light defoliation, by the oak leaf shredder, occurred in an area of Kent County.

In Prince Edward Island, oak leaf shredder caused light to moderate defoliation in a small stand at Brudenell Point, Kings County and light defoliation of oak trees occurred in Charlottetown and near Winslow, Queens County. Oak leafroller was not observed in the Province in 1988.

OTHER HARDWOOD DEFOLIATORS

Many insects of hardwoods are active in the forest each year. The majority are either of little consequence or of only local concern. These are listed in the chapter "Other insects and diseases" in this report. The few hardwood insects of major importance are discussed in separate chapters. Still others, of general distribution or for some other reason, are usually discussed here in some detail to bring them to the attention of the reader.

In 1988, as in 1987 and 1986, most hardwood defoliators were only of localized concern, were found at generally low populations, and caused negligible defoliation. The statement made last year that these insects were noted more for their lack of damage than for having caused significant defoliation over large areas applies again in 1988. Consequently, no hardwood defoliators are included in this chapter this year.

CASEBEARERS, LEAFMINERS, AND SKELETONIZERS

Some insects with specialized feeding habits, which do not consume leaves and needles in the manner typical of most defoliators, are discussed in this chapter.

Casebearers spend their lives hidden in cigar-shaped cases, built of leaf or needle material, attached to the leaf surface. They reach out to feed only as far as the protection of the case allows. When the edible portion of the leaf is consumed the insect moves, house and all, to a new feeding location. Consequently, feeding by casebearers initially appears patchy but later in the season, if populations are high, the patches merge and the foliage becomes generally discolored.

Leafminers live hidden between the upper and lower protective layers of the leaf and feed on the green inner portion. In the process, the leaf becomes discolored. The extent of discoloration depends on the amount of green tissue consumed. Some species consume much of the leaf, others cut off water supply to portions of the leaf, which then turns brown. Still others travel in a characteristic fashion within the leaf, in a pattern typical of the insect species.

Skeletonizers feed on the surface of leaves, usually on the underside, leaving the veins and the upper surface intact. Damaged tissue turns brown due to exposure to air and to lack of water reaching it and the leaves appear scorched. Heavily skeletonized leaves dry up and fall prematurely, thus feeding by these insects results in defoliation.

On Birch

Birch Casebearer, *Coleophora serratella* (L.), an introduced insect, first reported from Maine in 1927, is now widely spread throughout the Maritimes. Its preferred host is white birch but other species of birch and alder are also affected. At low populations the insect causes leaf spotting and foliage discoloration and is merely an aesthetic inconvenience. However, when populations are high, the discoloration becomes serious and repeated attacks by the insect cause decline in vigor, loss of growth, and death of young trees.

In 1988, in New Brunswick, birch casebearer populations increased over last year's levels and caused moderate and, in a few cases, severe browning of white birch and alder in some areas.

Severe browning of alder occurred at Melrose and Harewood, Westmorland County; moderate browning of white birch was observed in several areas in Gloucester County and occurred at locations in Kent, Westmorland, Queens, Sunbury, Carleton and Victoria counties. Light or trace foliage discoloration was common throughout much of the Province.

In Nova Scotia, the insect occurred throughout the Province and caused light to moderate foliage discoloration of white birch but only trace to light leaf browning of wire birch, yellow birch and alder. The highest level of foliage discoloration recorded on white birch was 55% at Middleboro, Cumberland County on the mainland and 53% at Fox Back Lake, Victoria County, in Cape Breton Highlands National Park.

In Prince Edward Island, browning of alder foliage was much more pronounced than that of wire birch and was particularly severe in many areas of Prince County and in a few patches scattered in the other two counties. On white birch, casebearer populations were variable in the Province and affected 75% of the leaves in Prince County (at Tignish), 63% in Queens County (at Auburn) and 39% in Kings County (at Goose River).

Birch Leafminer, *Fenusa pusilla* (Lep.), an introduced insect first observed in 1923 in Connecticut, has spread throughout Canada from Newfoundland to Alberta. The birch leafminer is a perennial pest in the Maritimes preferring wire birch but also commonly found on white birch.

In 1988, leaf browning of wire birch and, to a lesser degree, white birch increased in Nova Scotia, decreased in New Brunswick and remained about the same in Prince Edward Island, compared to 1987. In New Brunswick, although the insect was present throughout, moderate discoloration was observed only at King Brook Lake, Charlotte County, where wire birch was affected. In Nova Scotia, light to moderate foliage discoloration of wire birch occurred throughout with scattered patches of severe leaf browning. The highest number of affected leaves was 96% on wire birch at Pleasantfield, Queens County and 71% on white birch at Lake Rossignol, Queens County. In Prince Edward Island, the insect was present on both species of birch but caused only minimal leaf browning.

Ambermarked birch leafminer, *Profenusa thomsonii* Konow, caused varying degrees of foliage browning of white birch, wire birch and yellow birch at seven locations in the southeastern part of New Brunswick. Moderate discoloration occurred only at one location, on wire birch at Searsville, Kings County, but as much as 80% of the leaves were affected in some areas. In Nova Scotia, the insect was found at only four locations and caused only trace or light discoloration. This leafminer was not found in Prince Edward Island.

Birch Skeletonizer, *Bucculatrix canadensisella* Cham., outbreaks occur periodically in the Maritimes. The insect prefers white birch but other species of birch are also subject to attack. An outbreak, reported in 1977, covered extensive areas in Nova Scotia and eastern Prince Edward Island. Outbreaks occurred again in 1985 and resulted in moderate or severe foliage discoloration on Cape Breton Island, Nova Scotia, in parts of southeastern New Brunswick and in central Prince Edward Island. The outbreak persisted on Cape Breton Island in 1986 but subsided significantly in 1987 and only scattered patches of moderate foliage discoloration were observed.

In 1988, birch skeletonizer was of some consequence only in Nova Scotia where both the incidence and intensity of foliage discoloration increased over previous levels. Skeletonizing of white birch was mainly in the moderate category and averaged 46%, but patches of both severe and light leaf damage also occurred. Cape Breton and Colchester counties appeared to have sustained the most damage even though the highest level of

discoloration - at 100% of foliage affected - was observed at Neil's Harbour, Victoria County, Pleasant Valley, Halifax County and Minasville, Hants County. In New Brunswick, trace skeletonizing occurred at only two locations, one each in Kent and Kings Counties. The insect was not found in Prince Edward Island.

On Larch

Larch Casebearer, *Coleophora laricella* (Hbn.), an introduced species, is considered by some to be second in importance only to the larch sawfly as a foliage feeder on larch. The insect is usually present, but widespread, persistent outbreaks have not occurred in recent years. Populations are regulated by natural control factors, including the introduced parasites *Chrysocharis laricinellae* (Ratz.) and *Agathis pumila* (Ratz.), and by weather conditions. In the past, populations were high in 1943, 1952, and 1959. Widespread defoliation occurred over much of Nova Scotia in 1985 which was especially extensive and severe in the western half of the Province. In 1986, populations of the larch casebearer were much reduced and moderate and severe defoliation occurred only on individual or small groups of trees. The larch casebearer was common in many areas of the Region in 1987 but population levels remained generally low and little defoliation resulted.

In 1988, populations remained generally low in all three provinces and caused only trace or light needle browning. Moderate browning occurred occasionally in individual or small groups of trees, the highest having been recorded at Middle Beaver Lake, Halifax County, where 65% of the needles were affected and at Rogers Brook in Kejimkujik National Park, Annapolis County, where 64% of the needles were brown.

On Poplar

Poplar Serpentine Leafminer, *Phyllocnistis populiella* Cham., an insect found throughout Canada, mostly on trembling aspen, has a habit of wandering inside the leaf, taking sharp turns and doubling back, hence its name. Affected leaves take on a silverish-grey hue and when populations are high the affected stand has a silvery appearance. The damage potential of this insect is uncertain but it has been reported in the literature that heavy, persistent attacks by this leafminer result in growth loss and can lead to tree mortality.

The insect, while present throughout the Maritimes, was not a concern until 1976, when varying levels of foliage discoloration occurred in northeastern New Brunswick and in Albert and Queens counties in the southern part of the Province. By 1981, a major infestation existed throughout northern and central New Brunswick, causing trembling aspen over large areas to become silvergrey in appearance during the summer. The outbreak has persisted over much of the same area since that time, with expansion to the south in recent years.

In 1988, serpentine leafminer populations were high in New Brunswick, generally low in Nova Scotia and very low in Prince Edward Island.

In New Brunswick, high populations caused a silverish-grey appearance of trembling aspen stands throughout much of the northern and central parts of the Province (Fig. 7). In the north, an average of 43% of the foliage was affected on 91% of the trees; in the south, an average of 22% of the leaves were affected on 66% of the trees. The figures for the north are very close to those obtained a year ago; however, in the south, even though incidence is somewhat lower than in 1987 (from 72% to 66% in 1988), the intensity of the infestation increased to 22% from the 12% of one year earlier.

In Nova Scotia, leaf mining was generally low, the highest intensity, at 30%, having been recorded at Outram, Annapolis County.

In Prince Edward Island, low populations were present throughout the Province but the highest intensity recorded was only 7% of leaves affected.

DROUGHT AND HARDWOOD BRANCH MORTALITY

Stress on hardwood trees, predominantly sugar maple, due to severe drought conditions in 1987 resulted in extensive branch mortality in the spring of 1988. Death occurred at or shortly after bud break, branches affected were predominantly lower branches facing roads or streets. Leaves on the affected branches wilted, often changed to a yellowish color, shrivelled and then died. The cambium of affected branches was dry and they died from the base outward, unlike the manner of normal dieback. In Fredericton, many of the affected branches were observed to have shown stress symptoms last

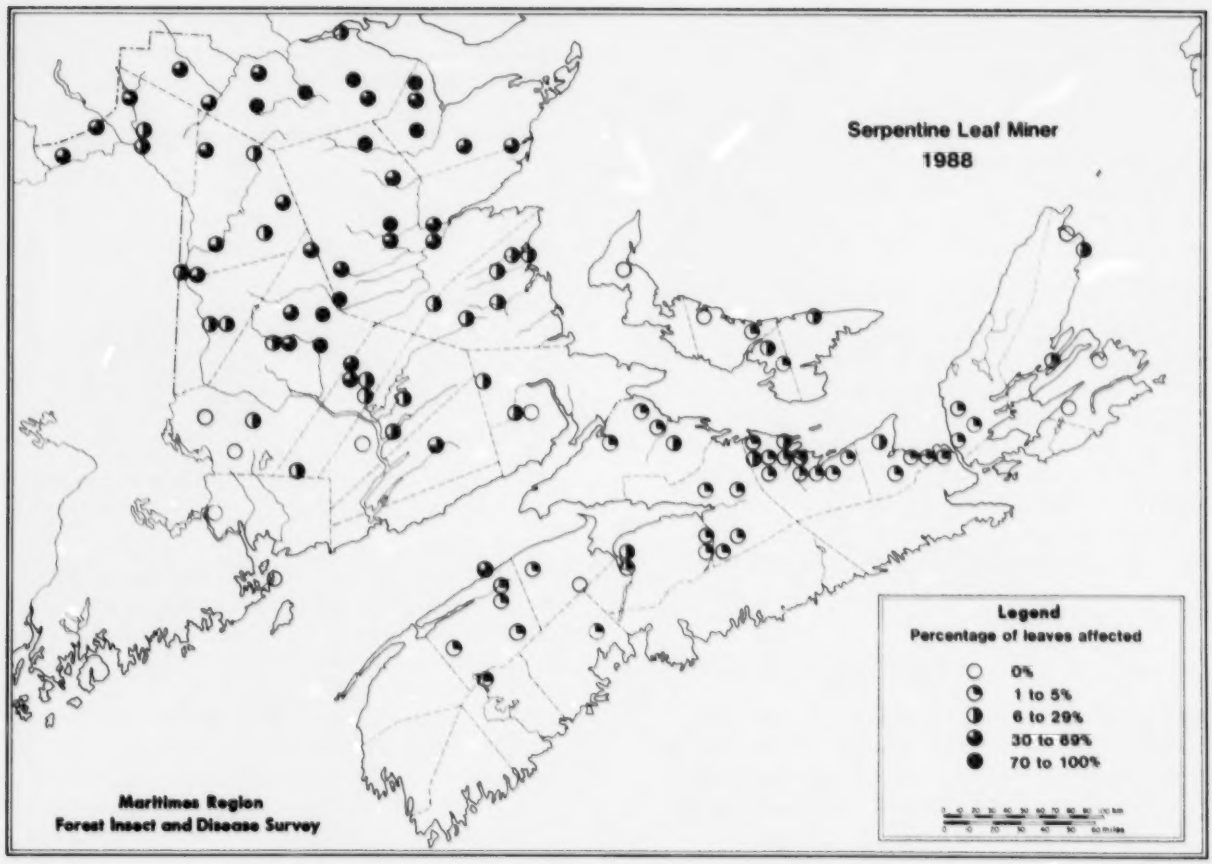


Figure 7

summer, i.e., very early foliage discoloration and leaf drop, and most were observed to be lower branches facing or overhanging pavement or in other stress situations.

Branch mortality occurred throughout New Brunswick along roads and in urban areas, particularly in the southern two thirds of the Province. In natural forests, the condition occurred only at the edge of the stands and was not observed more than 10 m away from road sides. Trees were most seriously affected in cities, towns, and villages. In most cases, branch mortality, in both rural and urban situations, was restricted to the loss of the branches initially affected. However, in some areas, notably in Fredericton, branch mortality on some trees was progressive and trees died.

Sugar maple was by far the tree species most affected but a similar type of branch mortality occurred on red maple, elm, oak, and other hardwoods as well. Almost all the trees affected were more than 25 years old.

The condition was not noted in Nova Scotia.

In Prince Edward Island, sugar maples in ornamental, hedge-row, roadside, and stand-edge settings were affected at scattered locations in Queens County, including Bonshaw and Blooming Point Road. Branch mortality involved no more than 2-3 branches per affected tree.

DUTCH ELM DISEASE

Dutch Elm Disease, caused by the fungus *Ceratocystis ulmi* (Buism.) C. Moreau, was of major concern in all three Maritime provinces in 1988 (Fig. 8).

In New Brunswick, the disease is present

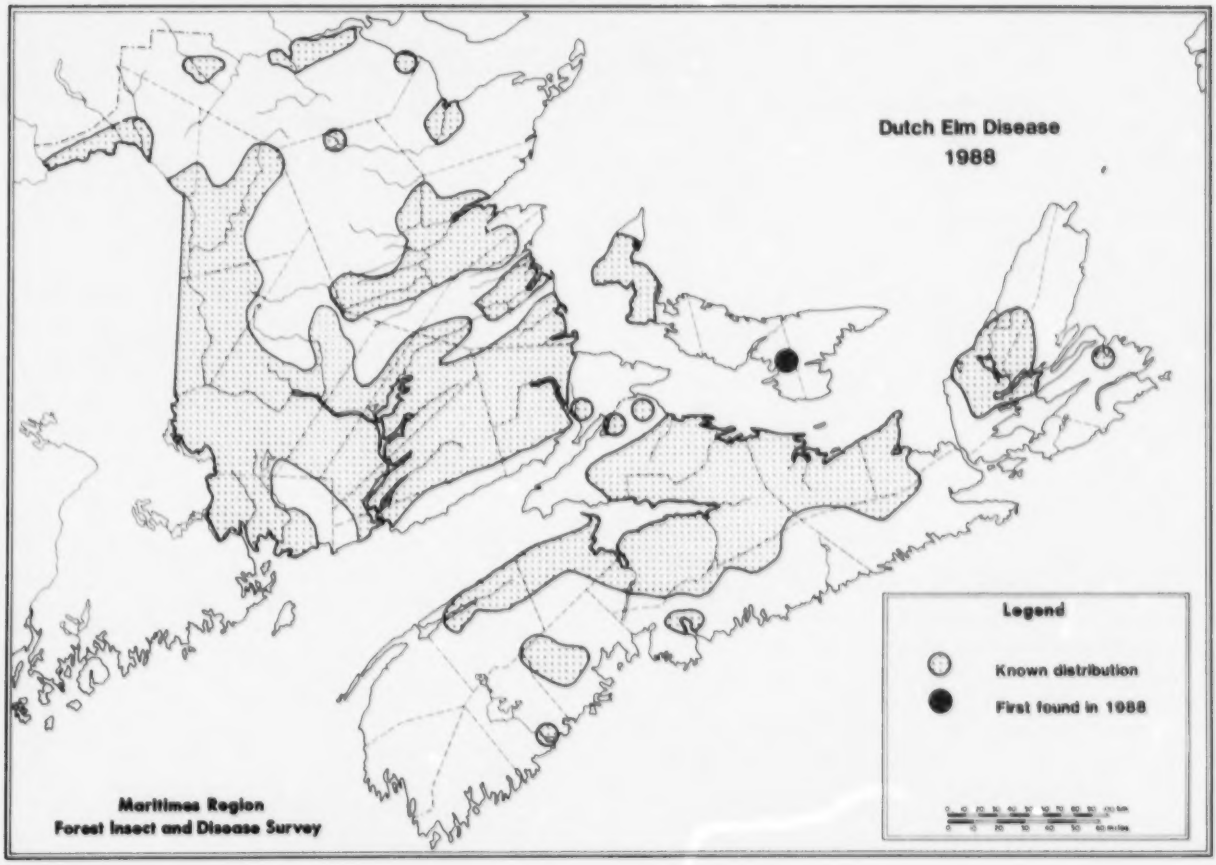


Figure 8

wherever elm trees are found. The resurgence of infection, reported in 1984, continued, especially along river valleys. Numerous infected and dying trees, both residual old trees and young saplings, were observed throughout the Province in 1988.

In Nova Scotia, the intensification of the disease, evidenced by great numbers of dead and dying elm trees, continued within outbreak areas where no sanitation is practised. No new infections were found outside the known range of the disease in 1988.

In Prince Edward Island, a major change occurred in 1988 in the status of Dutch elm disease. The disease was first discovered in 1979 in a small area of north-central Prince County. The initial discovery was followed by an immediate and vigorous sanitation cut by the provincial government. No infected trees were found in 1980 and 1981, one infected tree was identified and removed in 1982, none were found in 1983 and 1984, one tree was found in 1985 and two trees in 1986. In 1987, infected trees were found at eight locations at widely separated areas of western Prince County. Although the incidence of infection was generally low, the spread of the disease in this part of the Province was of concern.

In 1988, the discovery of a newly infected mature elm tree at Alberry Plains, Queens County extended the distribution of Dutch elm disease eastward by approximately 90 km. The infected tree was promptly removed by the owner to minimize the danger of creating a new infection centre in the eastern part of Prince Edward Island. There were few, if any, newly infected trees in western Prince County.

In Fredericton, the progress of Dutch elm disease and the effects of the control program have been monitored since 1961, when the disease was first found in the city. The 31 trees killed by the

disease in 1988 represented 1.0% of the current elm population within the Dutch Elm Disease Management Area. This loss is well in line with the reduction in the loss rate since 1980 when it peaked at 7.8%. The annual loss rate during the 1980s is as follows:

1980	7.8%
1981	5.3%
1982	3.0%
1983	2.4%
1984	1.1%
1985	1.3%
1986	0.8%
1987	1.0%
1988	1.0%

Losses to date amount to 29.3% of the original urban elm stand.

No systematic survey was conducted by the Forest Insect and Disease Survey in 1988 for elm bark beetles, the carriers of Dutch elm disease, except in Fredericton, where populations of the native elm bark beetle, *Hylurgopinus rufipes* (Eichh.), remained low. The European elm bark beetle, *Scolytus multistriatus* (Marsh.), was not captured in 1988. This insect, the most important vector in spreading Dutch elm disease in the United States has not been a factor to date in Fredericton. Single adults were captured in pheromone traps in 1982 just south of the City and in 1983 at Tay Creek, some 30 km to the north. In 1986 and 1987, single adults were captured on sticky band monitoring traps.

SEED ORCHARD PESTS

The establishment of seed orchards created a new category of high value areas in the Maritimes Region. Seed orchards and seed production are as important to nursery programs as seedling production in nurseries is to plantation programs. Consequently, anything that interferes with seed orchards also affects most other phases of forestry operations aimed at future wood production. Forest pests in seed orchards, both insects and diseases, have the potential to seriously affect seed production, either directly, by destroying seed or cones, or indirectly, by affecting the condition of trees, thus interfering with their ability to produce seed.

The number of samples from seed orchards increased again this year and reflects both the increase in seed orchard activity by various agencies and the fact that any seed loss from insect, disease or abiotic causes is quickly noticed in these valuable stands.

The following, which is not intended to be all inclusive, was prepared in cooperation with R.F. Smith, Forestry Canada - Maritimes, to give an overview of problems encountered in seed orchards in 1988.

There was a heavy cone crop throughout the Maritimes in 1988. Cones, seeds, and orchard trees were examined in greater detail for damage than in previous years, due partly to the abundance of cones, to the increasing expertise of seed orchard staff in problem recognition, and to the existence of a contract for the development of pest monitoring systems, jointly funded by the Canada/New Brunswick and the Canada/Nova Scotia Forest Renewal Agreements.

Insects

Spruce cone maggot, *Hylemya anthracina* (Czerny), damage was found in most white spruce orchards in Nova Scotia; however, usually on isolated trees and at fairly low levels.

Coneworms, *Dioryctria* sp., were found in small numbers on spruce, jack pine, and larch at various seed orchards in the Region.

The **spruce budworm,** *Choristoneura fumiferana* (Clem.), caused moderate to heavy cone losses in one black spruce seedling seed orchard in New Brunswick.

A single larva of the **Zimmerman pine moth,** *Dioryctria zimmermani* (Grt.), girdled the 5 cm stem of a jack pine tree in a New Brunswick seed orchard.

Spruce bud scale, *Physokermes piceae* (Schr.), damage was severe on a few black spruce at a New Brunswick seed orchard and light on red spruce at a Nova Scotia orchard.

Insects affecting orchard trees, but not directly affecting the seeds or cones, included a **budmoth,** *Zeiraphera* sp., light on white spruce at a Nova Scotia orchard; **spruce budmoth,** *Zeiraphera canadensis* Mutuura & Freeman, trace on white spruce at another Nova Scotia orchard; **larch casebearer,** *Coleophora laricella* (Hbn.), light on larch at a New

Brunswick seed orchard; **spruce bud midge,** *Rhabdophaga swainei* Felt, typically trace on spruce but light at one New Brunswick orchard; a **tip beetle,** probably *Conophthorus banksianae* McP., present on a few jack pine at a New Brunswick seed orchard; **orange spruce needleminer,** *Coleotechnites piceaella* (Kft.), present on black spruce in one New Brunswick orchard; a **cutworm,** probably *Anomogyna sp.,* feeding in small numbers on male spruce flowers at a New Brunswick seed orchard; a **leaf beetle,** *Syneta extorris borealis* Brown, present on jack pine at a New Brunswick orchard; **European pine shoot moth,** *Rhyacionia buoliana* (D. & S.), common on red pine buffer trees around a Nova Scotia seed orchard.

Aphids and Mites

In general, infestation levels of aphids and mites were reduced from last year throughout seed orchards in the Region, probably because more rain in 1988, especially in Nova Scotia, created conditions less favorable for these pests than was last year's hot dry summer.

Populations of spider mites, *Tetranychidae,* remained moderate to high in red spruce at one Nova Scotia seed orchard but, overall, the severe spider mite problems reported throughout the Maritimes in 1987 declined sharply in 1988.

Aphids, including *Cinara* sp.; *Adelges* sp.; the **eastern spruce gall adelgid,** *Adelges abietis* (L.); the **ragged spruce gall adelgid,** *Pineus similis* (Gill.); the **spruce twig aphid,** *Mindarus obliquus* (Cholod); and the **pine leaf adelgid,** *Pineus pinifoliae* (Fitch), were present throughout Maritime orchards; however, only at very low levels. In one Nova Scotia seed orchard, Cinara sp. appeared to be more common on fertilized red spruce than on adjoining unfertilized trees.

Diseases

The spring and early summer of 1988 was cool and damp for most of the Region. This provided conditions deemed conducive to the development of many of the diseases affecting orchard trees, cones, and seed. With 1988 being a 'bumper' cone crop year, cone and seed borne diseases were particularly evident.

Sirococcus shoot blight, *Sirococcus conigenus* (DC.) P. Cannon & Minter, was collected on white spruce cones at 13 Nova Scotia locations (of 17 locations sampled). The average number of infected cones was 22.1% (range from 3 to 73% infected).

Scleroderris canker, *Gremmeniella abietina* (Lagerb.) Morelet, was present again at high levels in a New Brunswick jack pine seedling seed orchard. Lower limb pruning of infected trees was carried out in 1987; the effects of the control should be noticeable by 1989.

Spruce needle rust, *Pucciniastrum americanum* (Farl.) Arth., was present in all white spruce orchards in the Region, although mostly at low to trace levels. In two Nova Scotia seed orchards, 49% and 67% of the white spruce cones, respectively, were affected. The level of infection per cone, however, was low; therefore, only minor seed loss occurred.

Cones collected from stands in Nova Scotia were also infected; the level of infection from 17 locations ranged from 1 to 100% of the cones, with five locations negative for rust. The average number of infected cones was 31.4%. At the Kathy Road, Cape Breton Highlands, all cones were infected with 36% being a total loss due to multiple rust infections per cone.

Spruce cone rust, *Chrysomyxa pirolata* Wint., was found only on a few spruce cones at seed orchards throughout the Region.

Armillaria root rot, *Armillaria mellea* (Vahl ex Fr.) Kummer, was found on a few trees in a black spruce family test in Nova Scotia and in one and three black spruce seed orchards in Nova Scotia and New Brunswick, respectively.

Needle rusts on various hosts were present but in insignificant amounts.

Globose gall rust, *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka, was again a problem in several jack pine seed orchards in New Brunswick. Removing galls by pruning infected limbs was done in three seedling orchards and one clonal orchard.

Abiotic causes

Frost caused considerable damage to young developing female cones in a white spruce seed orchard in Nova Scotia and light damage in another. The terminal portions of many cones were killed (10% to 30% of the affected cones), resulting in a concomitant loss of seed from the damaged scales.

Winter dessication, usually of rootstock foliage only, was evident in white and red spruce grafts in two Nova Scotia orchards.

Snow damage was light on white spruce and trace on tamarack in a New Brunswick seed orchard.

Mouse damage, resulting in the loss of several hundred grafts of both white and Norway spruce, occurred in a Nova Scotia orchard, where rodent damage had never occurred before. The combination of an early snow cover in the fall of 1987, the resulting lack of ground freezing, and some site preparation work (white spruce only) probably contributed to the rodent population explosion in the orchard.

Animal damage, in the form of feeding by **porcupines** and **deer,** was present in several tamarack orchards in New Brunswick. Minor stem scarring by deer occurred in one white pine orchard in Nova Scotia.

NURSERY AND GREENHOUSE PESTS

Successful seedling production is essential to avoid or at least to minimize the shortfalls in wood production predicted to occur in the future. Seedling production is as important to plantation programs as seed production is to nurseries. Pests affecting nursery production increase the cost of meeting the objectives of forestry.

Of the conditions encountered in 1988 in nurseries and greenhouses, some are mentioned here because of their importance, while others demonstrate that no facet of forestry is without problems. Although the insects and diseases mentioned may appear insignificant, they did occur in spite of constant vigilence and continuing control measures. Good nursery practices have limited their damaging potential. Abiotic problems were widespread and severe in 1988. Considerable seedling losses occurred and many "surviving" trees were injured to some extent.

The following, which is not intended to be all inclusive, was prepared in cooperation with R.D. Hallett and T.W. Burns, Forestry Canada - Maritimes, to give an overview of problems encountered in nurseries and greenhouses in 1988.

Diseases

The gray mold, *Botrytis cinerea* Pers. ex Fr., was heavy on 1.5 million 1-year-old jack pine container stock overwintered at a New Brunswick nursery. The cold spring weather allowed snow to persist and provided ideal growing conditions for the mold on the seedlings. This crop was treated at planting to minimize disease spread. Elsewhere, gray mold was very common as a secondary infection whenever seedlings were stressed or injured by abiotic problems between seed germination and their outplanting.

Sirococcus shoot blight, *Sirococcus conigenus* (DC.) P. Cannon & Minter, was not reported from forest nurseries in the Maritimes in 1988.

The smothering fungus, *Thelephora terrestris* Ehrh. ex Fr., was present among 2-0 black spruce container stock in the holding area of a Nova Scotia nursery. These large seedlings provided ideal conditions under their dense foliage canopy for the growing of both smothering fungus on the soil surface and the gray mold, *Botrytis cinerea* (mentioned earlier), on the suppressed branches.

Two **cup fungi,** a *Plicarai* sp. and *Peziza repanda* Pers., were common among white spruce and black spruce, respectively, at two separate forest nurseries in New Brunswick. The *Peziza* was large enough to obstruct some water from reaching the soil in solid wall containers, but otherwise they were not harmful.

A **needle rust,** *Coleosporium asterum* (Diet.) Syd., was trace on about 2000 potted red pine in the holding area of a New Brunswick nursery.

Insects

A **cutworm,** probably a *Polia* sp., caused damage in a 16-week-old crop of black spruce at a New Brunswick container nursery.

The **strawberry root weevil,** *Otiorhynchus ovatus* L., was present, but apparently controlled, in a Nova Scotia container nursery.

Abiotic factors

The actual number of seedlings lost in forest nurseries in the Maritimes during the year is not known. However, there were unreported losses of crops involving large numbers. These losses are

often caused by abiotic problems which are man-made, and are greater than losses to insects and diseases combined. Many of these problems could be prevented by better management and cultural practices.

One principal cause of abiotic injuries has been raising **seedlings too big for the container.** This condition results from inappropriate scheduling of container crops in relation to planting seasons. When the crop continues to grow, the resulting oversized seedlings are prone to a variety of problems including deterioration of shaded foliage, root dieback, and establishment of diseases like gray mold. Then the protection of such crops becomes a situation requiring use of pesticides and good luck in terms of climatic conditions favoring their spread. Disfigured crops may not do well in plantations, consequently poor performance and additional mortality can be expected.

Abiotic problems also included **poor root development, watering problems, overwintering injury, fertilizer burn, and frost damage, alone or in combination.** The impact of non-lethal abiotic injury on plantation establishment is difficult to measure but should not be minimized or overlooked. For example, significant losses occur when apparently healthy seedlings are outplanted and fail to become established when exposed to normal moisture stress in new plantations.

CHRISTMAS TREE PESTS

Many pests of balsam fir Christmas trees are mentioned elsewhere in this report. The balsam gall midge and the balsam twig aphid are discussed here because of their widespread occurrence both in Christmas tree areas and in natural stands and because they effect the quality and, consequently, the value of Christmas trees.

The following, which is not intended to be all inclusive, was prepared in cooperation with G. Estabrooks and D. Marks, Forestry Canada - Maritimes, to give an overview of problems encountered in Christmas tree production areas in 1988.

Balsam gall midge, *Paradiplosis tumifex* Gagne, populations were again low throughout the Region in 1988 except for a few isolated locations. In New Brunswick, populations were widespread but remained low, affecting 3% of the needles on 35% of the trees at the 44 locations assessed. The highest infestation was observed in a small Christmas tree plantation at Fredericton, York County. The level of infestation by the balsam gall midge was determined at 765 locations during spruce budworm L_2 surveys conducted by the New Brunswick Department of Natural Resources. Of these, 532 (70%) were negative; at 226 (30%) locations 1-10% of the needles were affected; at 7 locations the infestation was in the 11-20% range. These figures, although very low, are somewhat higher than in 1987 when 90% of the observations were negative. Although the above represents samples from larger, older trees, used to determine spruce budworm populations, the figures are comparable to our results obtained from Christmas tree plantations and are a good indication of the distribution of balsam gall midge populations in the Province in 1988. In Nova Scotia, an average of 2% of the needles were affected (range 0 to 14%), the highest level of infestation having been observed at Diligent River, Cumberland County. A special survey by the Nova Scctia Department of Lands and Forests found only 2% of the 366 observations in the light (6 to 29%) category, 27% were trace and no balsam gall midge infested needles were found in 71% of the samples. In Prince Edward Island, balsam gall midge was found at Goose River, Kings County where a few needles of a few trees were infested.

Balsam twig aphid, *Mindarus abietinus* Koch, infestations were common throughout the Maritimes although damage to new shoots was not serious. Infestations increased in New Brunswick and affected, on average, 13% of current shoots on 50% of the trees assessed at 63 locations. These figures are much higher than the average of 6% of shoots affected on 33% of the trees at 63 locations, reported in 1987. This increase has also been noted in a survey by the New Brunswick Department of Natural Resources. They found balsam twig aphid damaged shoots "present" at 299 of 766 locations. This represents 39% positive locations, compared to 16% in 1987. Infested shoots were most common in the northwestern part of New Brunswick (DNR Region 5) where 59% of the samples contained some damage. In Nova Scotia, balsam twig aphid was common throughout the Province but infestations were usually light. An average of 10% of the shoots were damaged (range 0-68%), the highest infestation having been recorded at Springfield, Annapolis County. Balsam twig aphid was found at more than half (57%) of the 366 locations surveyed by the Nova Scotia Department of Lands and Forests but damage was classified as moderate at less than 3% of the

locations. At the majority of positive locations (131 of 210, or 62%), less than five percent of the new shoots were affected. In Prince Edward Island, light damage occurred at two locations in Queens County.

Yellow witches' broom of balsam fir, *Melampsorella caryophyllac-earum* Schroet., a rust fungus which needs chickweed as an alternate host to complete its life cycle, is often found in the natural forest, but has not been a serious problem in Christmas tree plantations in the Maritimes until recently. Serious damage occurred in the mid-1980s in a few plantations, especially in areas where chickweed ground cover was heavy, and affected the quality of Christmas trees. In 1988, single brooms on scattered trees were common throughout Nova Scotia. The average number of infected trees was 11% and infection rate was as high as 52% of trees affected at Debert, Colchester County and 46% at St. Anns, Victoria County. Brooms were found at three locations in New Brunswick. No diseased trees were found in Prince Edward Island.

Shoot mortality on balsam fir trees. The cause of sudden wilting, curling, and finally browning and death of lateral shoots and leaders of balsam fir trees in both planted and wild Christmas tree areas at widely scattered locations in the Maritimes has been unexplained for the past two years. The early suspects (disease, herbicide, fertilizer) have been eliminated as causal agents.

The condition recurred again in 1988 and more trees suffered shoot mortality. The following common factors were observed at all affected sites: (1) exposure to drought in the late summer of 1987 and in 1988; (2) heavy cone production on more mature trees in 1988; (3) thin soil with rapid drainage through underlying sand and gravel; (4) most severely affected trees associated with the poorest sites in a given area; and (5) additional stress (poor roots, butt pruning, etc.) intensified condition.

Based on the above, it is suggested that shoot mortality is associated with stress caused by drought and is intensified on poor sites. (Thanks to R. Hallett, Forestry Canada - Maritimes, for this scenario and to extension foresters for the various observations which led to the explanation of this condition.)

Drought affected Christmas trees in parts of Antigonish County, Nova Scotia. Older needles turned yellow and dropped prematurely, rendering some trees unmarketable.

SPECIAL SURVEYS

Several forest pest surveys are carried out annually that are not necessarily related to forest pests of major importance. Considering the implications this information may have in forest management, summaries and results of these special surveys have been included in our annual report.

ACID RAIN NATIONAL EARLY WARNING SYSTEM

Acid rain has been a global concern for the past decade and the effects of impurities in the air and on lakes, buildings, and the forest are becoming more apparent in many parts of the world.

Acid rain means more than just rain with lower than normal pH. It includes any form of acid precipitation, both wet and dry, and air pollutants of different kinds. These, alone or in combination, directly or indirectly affect the health of Canada's forests by interfering with their normal development, the production of wood, or with their role in providing a healthy environment.

Concern over the future of the Canadian forests has intensified as a result of the alarming tree mortality observed in other parts of the world. The Acid Rain National Early Warning System (ARNEWS) came into being in the early part of 1984, when Forestry Canada established a national program to detect, clearly and accurately, early signs of acid rain damage to Canada's forests before such damage becomes obvious.

The objectives of the program are:

1. To detect the damage to forest trees and soils, if any, caused by acid rain or to identify the damage sustained by Canadian forests (trees and soils) which is not attributable to natural causes or to management practices;

2. Long-term monitoring of vegetation and soils to detect future changes attributable to acid deposition and other air pollutants in representative forest ecosystems.

The Forest Insect and Disease Survey was charged with the responsibility for (1) plot establishment, (2) above-ground parameter monitoring and sampling, and (3) providing assistance in obtaining foliage and soil samples for chemical analysis.

ARNEWS Plots

Permanent plots are maintained in all regions of Canada to monitor:

a. the condition and changes in the condition of the forest stand;
b. the presence and fluctuation of biotic and abiotic factors that effect the condition of the forest (insects, diseases, stand changes, temperature, etc.);
c. the changes and symptoms that indicate factors not attributable to the above which could conceivably be early signs of acid rain damage; and
d. the effect of acid rain on the condition of the various economically important tree species.

The rationale behind the above is that, without close monitoring of all of the factors mentioned, the expected, initially subtle, effects of acid rain cannot be isolated and identified.

In the Maritimes Region, 15 permanent ARNEWS plots, representing the important forest species and geographical areas, were established in 1984. Two additional plots have been established in northwestern New Brunswick in 1985 at the request of and in cooperation with Fraser Inc. These will be monitored jointly with the Company in future years.

In 1988, all 17 plots were visited monthly from June to September to: determine forest insect and disease conditions; detect 'acid rain' symptoms (if any); observe seed crop and premature fall discoloration; and collect ground vegetation samples. In August, detailed assessments of all plots were carried out following the procedures developed by the Maritimes FIDS unit for the national system (DPC-X-25, Magasi, 1988).

Foliage and soil samples are now available for analysis from all ARNEWS plots in the Maritimes. Information from increment cores collected in 1984 has been computerized in cooperation with the Petawawa National Forestry Institute.

Tree mortality, a topic often raised during acid rain related discussions, is assessed annually on all ARNEWS plots. A summary of tree mortality at the ARNEWS plots in the Maritimes (Table 7) shows that an average of 1.6% of the trees on these plots died annually between 1984 and 1988. This figure includes mortality from all causes. For example, almost half (48%) of the 29 balsam fir trees that died during this period were on two plots (212, 213) in eastern Nova Scotia and another 34% on three plots (202, 216, 217) in northwestern New Brunswick, both areas of severe spruce budworm outbreaks. None of the 93 maple trees died on any of the ARNEWS plots, and all but one of the 8 hardwood trees that died, were white birch and were on the Martin Head plot (plot 206) in southeastern New Brunswick, where white birch is deteriorating (see below). Including these trees, the average annual hardwood mortality on ARNEWS plots in the Maritimes is 1.0%. The information to date does not indicate large-scale forest destruction in the Maritime Provinces from unexplained causes.

Needle Retention by Conifers

In addition to the work on permanent plots, the results of observations for signs of possible acid rain damage were recorded for most of the 346 locations where detailed pest condition assessments were made. Special attention was directed to the number of years of needle retention on coniferous species. A summary of some of these observations is presented in Table 8. It is apparent that the percent of needles retained decreases with age of foliage and the rate of the decrease varied among tree species and between provinces. It is important to realize that the figures represent provincial averages and, more importantly, that at least some of the loss is definitely attributable to feeding by defoliating insects. Similar information has been collected annually since 1985 in our effort to build a data base which will allow analysis of possible changes.

Unexplained Situations

Forest Insect and Disease Survey personnel are always on the lookout for unusual or unexplained forest conditions, some of which could conceivably be the result of acid rain damage. Unexplained forest conditions currently under observation are briefly described:

Table 7. Average tree mortality by species on the Maritimes ARNEWS plots between 1984 and 1988

Tree Species	No. of living trees 1984	No. of living trees 1988	Ave. annual mortality (%)
Conifers			
Balsam fir	276	247	2.6
Black spruce	51	47	2.0
Red spruce	157	150	1.1
White spruce	67	67	0
Spruce	47	43	2.1
Larch	26	25	1.0
Jack pine	54	49	2.3
White pine	37	36	0.7
Hemlock	3	3	0
Hardwoods			
Sugar maple	30	30	0
Red maple	63	63	0
White birch	75	68	2.3
Yellow birch	10	10	0
Wire birch	1	1	0
Trembling aspen	15	15	0
Largetooth aspen	2	1	12.5
Black cherry	1	1	0
Ash	3	3	0
Total	918	859	1.6

Condition of red spruce

In 1985, in the southern part of New Brunswick, red spruce was found to be deteriorating at many locations on Deer Island, Charlotte County. Although trees in many of these areas have been defoliated by the spruce budworm in the past, this does not adequately explain the condition observed. In 1986, permanent observation plots, each consisting of 50 trees, were established in Charlotte and Sunbury counties in New Brunswick and in Hants, Cumberland, and Halifax counties in Nova Scotia to follow changes in the condition of trees. The plot in Halifax County was cut in the summer of 1987. The summary of the tree conditions at the remaining 4 plots is presented in Table 9. Observations will continue to establish possible trends in condition changes.

Deterioration of white birch along the Bay of Fundy

Annually recurring, early, usually severe, foliage browning and premature leaf fall along the Bay of Fundy has resulted in serious deterioration of white birch trees in this area. The cause of the condition, first reported in 1979, is not known, but insects and diseases have been ruled out and some type of pollution is suspected as the causal agent. Multidisciplinary research was initiated in 1986 to investigate possible causes, including acid rain, acid fog, and ozone.

In 1988, foliage browning of white birch occurred again along the Bay of Fundy, both in New Brunswick and in Nova Scotia. The intensity of browning was variable from light to severe and the affected area was similar to those of previous years.

Table 8. Retention of needles produced in different years by various coniferous trees in the Maritimes Region - 1988

Species	Province	No. of observations	Needles retained of the needles produced in the year indicated (%)							
			1988	1987	1986	1985	1984	1983	1982	1981
Balsam fir	New Brunswick	85	95	90	79	70	56	32	18	10
	Nova Scotia	82	100	98	93	85	71	51	32	12
	Prince Edward Is.	4	99	54	70	65	58	45	25	0
White spruce	New Brunswick	32	97	97	92	77	63	40	19	9
	Nova Scotia	68	99	98	93	86	84	48	21	7
	Prince Edward Is.	13	90	86	78	63	47	24	12	5
Black spruce	New Brunswick	30	100	98	90	81	68	47	23	21
	Nova Scotia	11	100	99	91	85	73	41	16	6
	Prince Edward Is.	1	100	100	90	80	70	60	50	0
Red spruce	New Brunswick	24	99	95	91	85	71	48	33	23
	Nova Scotia	40	100	99	91	82	62	37	19	9
	Prince Edward Is.	1	100	90	90	80	60	40	10	10
Spruces (combined)	New Brunswick	86	99	97	91	81	67	45	25	18
	Nova Scotia	119	99	99	92	84	73	42	19	7
	Prince Edward Is.	15	97	92	86	74	59	41	24	5
Red pine	Nova Scotia	5	100	100	92	48	0	0	0	0
White pine	New Brunswick	4	98	83	35	0	0	0	0	0
	Nova Scotia	11	99	75	44	6	0	0	0	0
Jack pine	New Brunswick	5	100	96	84	0	0	0	0	0
	Nova Scotia	1	100	100	80	40	0	0	0	0
Pines (combined)	New Brunswick	9	99	89	60	0	0	0	0	0
	Nova Scotia	17	100	92	72	31	0	0	0	0
Hemlock	New Brunswick	1	100	95	80	10	10	10	0	0
	Nova Scotia	4	100	95	88	73	30	5	3	0

Table 9. Condition of red spruce at four permanent plots in the Maritimes 1986 - 1988

Tree condition classes	Percent of trees in various tree condition classes											
	New Brunswick						Nova Scotia					
	Charlotte Co.			Sunbury Co.			Hants Co.			Cumberland Co.		
	86	87	88	86	87	88	86	87	88	86	87	88
1. Healthy, no defoliation-	4	90	100	0	0	0	14	40	40	0	0	0
2. Healthy, only current defoliation	38	10	0	0	56	38	0	0	0	0	0	0
3. More than current but less than 25% total defoliation	50	0	0	64	30	50	46	68	54	12	16	22
4. Total defoliation 26-50%, no bare top	6	0	0	28	10	4	36	2	6	74	82	72
5. Total defoliation 26-50%, with bare top	2	0	0	8	0	2	4	0	0	14	2	2
6. Total defoliation 50-70%, no bare top	0	0	0	0	0	0	0	0	0	0	0	4
11. Total defoliation more than 90%, with bare top	0	0	0	0	2	0	0	0	0	0	0	0
12. Dead 1 year or less	0	0	0	0	0	6	0	0	0	0	0	0

Table 10. Condition of white birch along the Bay of Fundy in New Brunswick on 11 permanent plots, 1982-1988

Tree condition class	Percentage of trees in class						
	1982	1983	1984	1985	1986	1987	1988
No dieback	92.9	83.7	64.0	45.3	14.5	—	—
Twig dieback only	1.5	8.6	24.9	34.9	47.3	42.6	38.0
Twig and branch dieback	4.7	6.0	7.8	14.4	31.3	49.8	54.0
Dead	0.9	1.7	3.3	5.4	6.9	7.6	8.0

Each plot consists of 50 tagged trees.

Foliage discoloration occurred very much later than in past years but was unmistakably different from the normal autumn change in color usually observable around mid-September.

The condition of the trees has been assessed annually on permanent plots established in 1982. Summarized results from the 11 plots in New Brunswick are shown in Table 10.

Foliage browning, similar to that along the Bay of Fundy, also occurred in some other areas in Nova Scotia. The most severe browning occurred in coastal areas in southern Cumberland, Colchester, and Halifax counties and in parts of Cape Breton and Richmond counties.

Condition of white spruce at Loch Katrine, Antigonish Co., Nova Scotia

Chlorotic foliage has been observed since 1985 on white spruce trees near Loch Katrine, Antigonish County, Nova Scotia in an uneven-aged stand of about 20 ha. The current foliage is green, but all older needles on affected trees exhibit various levels of yellowish discoloration. Not all trees in the stand are affected, but trees from all age classes show similar symptoms. Yellowing is more prominent on the upper surface of needles than on the underside. Needle retention of older foliage is less than that normally found on unaffected trees. Some of the trees have thin crowns. The cause of this condition is unknown but no insects or diseases appear to be involved.

In 1988, the condition was present again and additional white spruce trees in the general vicinity exhibited chlorotic foliage. Neither foliage nor soil samples, collected in 1987, showed major differences between affected and non-affected areas which might have explained the chlorotic foliage.

CYCLICAL REVIEWS FOR SPECIFIC PESTS

Many pests, although omnipresent in the forest, are not reported annually because (1) there is little fluctuation in their distribution or in the damage they cause, (2) they normally cause so little damage that regular surveys cannot be justified, or (3) they are present in such small numbers that they are easily overlooked during routine assessment surveys. However, these organisms are a part of the pest component in the forest and, although separately each may cause little damage, their combined effects can weaken trees, reduce growth, or expose them to other problems. Forestry practices are changing and some organisms, until now obscure and unimportant in their natural habitat, are also changing in importance and the damage caused by them is becoming significant.

Several of these 'other' insects and diseases are reviewed in most years, often in connection with surveys involving a specific host species. The number depends on other activities, which determine the time available, and the time required for specific surveys. The results provide an assessment of the current status of the organism and a benchmark to which past and future assessments are compared.

Since 1982, when we first started reporting the results of cyclical reviews, the status of the following forest pests has been examined: larch shoot moth and spruce gall midge in 1982; balsam shootboring sawfly, eastern dwarf mistletoe, northern pitch twig moth and larch needle casts in 1983, the latter in response to concerns over the discovery of a newly introduced species to Canada; bronze birch borer and birch ambrosia beetle, in connection with the deterioration of white birch along the Bay of Fundy in 1984.

Other priorities since then have not allowed for special assessment of this type, but we plan to continue with cyclical reviews in the future, especially when supporting evidence is required to explain certain forest conditions.

PINEWOOD NEMATODE

The Pinewood Nematode, *Bursaphelenchus xylophilus* (Steiner and Buhrer) Nickle, has gained worldwide attention in recent years, mostly because of its implications for international trade of forestry products. (Reported as *B. lignicolus* in our 1985 report.)

Nematodes are a class of "elongated, cylindrical worms, parasitic in animals or plants or free-living in soil or water" (Webster's Seventh New Collegiate Dictionary, 1970). The pinewood nematode was first identified in North America in the late 1970s and was believed to have been imported from Japan, where it has been reported to have killed trees for at least 30 years. The pinewood nematode has been reported to be widely distributed in the United States and, in

1982, was reported in southern Manitoba. The nematode was found in Ontario in 1985, and in New Brunswick, Quebec, Manitoba, and Alberta in 1986.

The pinewood nematode is a plant-parasitic species which kills trees by rapidly multiplying in the water conducting elements, after having been introduced into the trees by some wood-boring insect, such as the sawyer beetle or the bark beetle. The actual vectors are not known but cerambycids are suspected. The affected tree, with its water supply cut off, wilts and dies within a short time. The fact that many species of nematodes may be present in trees, most of them not pathogenic, and that the identification of these microscopic organisms is extremely difficult, has resulted in considerable confusion as to the cause of tree mortality in some areas and as to the actual distribution of the pinewood nematode itself.

In the Maritimes, the pinewood nematode (referred to earlier as the "Japanese wood nematode") has been of special concern to the Forest Insect and Disease Survey since 1980. Through general observations, forest condition assessment surveys, plantation surveys, pest extension activities, provincial cooperative surveys, and special surveys, staff have been on the lookout for symptomatic suspect trees. In the five years from 1980 to 1984, 15 such trees were located. These included red pine, Scots pine, white spruce, and balsam fir. Nematodes were extracted from some of these and submitted for expert identification. Reports received indicated that none of the samples submitted were of the pinewood nematode. In 1984, suspect nematodes were extracted from two samples (one balsam fir, one white spruce). One sample contained two species of nematodes, a bacterial feeder and a mycophagous species (fungus eater). The nematode from the other sample was identified as 'definitely not pinewood nematode'. Also in 1984, a number of bark beetles from stressed balsam fir were tested as possible vectors for the pinewood nematode - with negative results.

Because of the plant quarantine importance of pinewood nematode, extensive surveys have been underway to detect its presence in trees since 1985 and in its possible vectors (carriers) in 1988. The two surveys are discussed below:

Tree surveys - 1985-1988

In the fall of 1985 and the summers of 1986 and 1987, a special survey was conducted in the Maritimes as part of a national effort to establish the presence and distribution of the pinewood nematode in Canada. Recently dead, old dead, and a few living trees were sampled and, from a number of locations, insects, considered possible vectors for the nematode, were also analysed. Samples were obtained from 207 locations, (131 in New Brunswick, 55 in Nova Scotia and 21 in Prince Edward Island). A further 21 locations were sampled in 1988. The distribution of sampling areas and results are shown in Figure 9, the various hosts sampled in Table 11.

Although the objective was to obtain a good species mix in sampling, balsam fir received special attention, especially in the early part of the survey, because of the similarity in symptom expression between Stillwell's Syndrome and the supposedly sudden wilting of conifers killed by the pinewood nematode. No pinewood nematode has been identified from any of the balsam fir trees that succumbed to Stillwell's Syndrome.

Pinewood nematode, the so-called "r" form of *B. xylophilus*, has been identified at five of the 228 locations (2.2%), from 7 of the 418 trees (1.7%) sampled. All "r" forms were identified from New Brunswick and all came from dead pine trees at Nevers Brook, Kent Co. (2 locations); Jeanne Mance, Gloucester Co.; Mount Hebron, Kings Co.; and Pleasant Mountain, Albert Co. A detailed description of these finds was provided in the 1987 annual report (Magasi, 1988).

Another *Bursaphelenchus*, the so-called "m" form, which is an affiliate of uncertain connection and is considered non-pathogenic, has been identified at 23 locations, 14 in New Brunswick and 9 in Nova Scotia. Two trees were infested at two locations; in the other areas, only individual trees were positive for the "m" form. Of the 25 infested trees, 18 were balsam fir and one each of black spruce, red spruce, Scots pine, eastern white pine, and jack pine were found infested. All but one of the trees from which the "m" form was extracted were recently dead, the exception being an old-dead eastern white pine tree from Nova Scotia. The highest number of "m" form nematodes extracted from infested trees was 18.

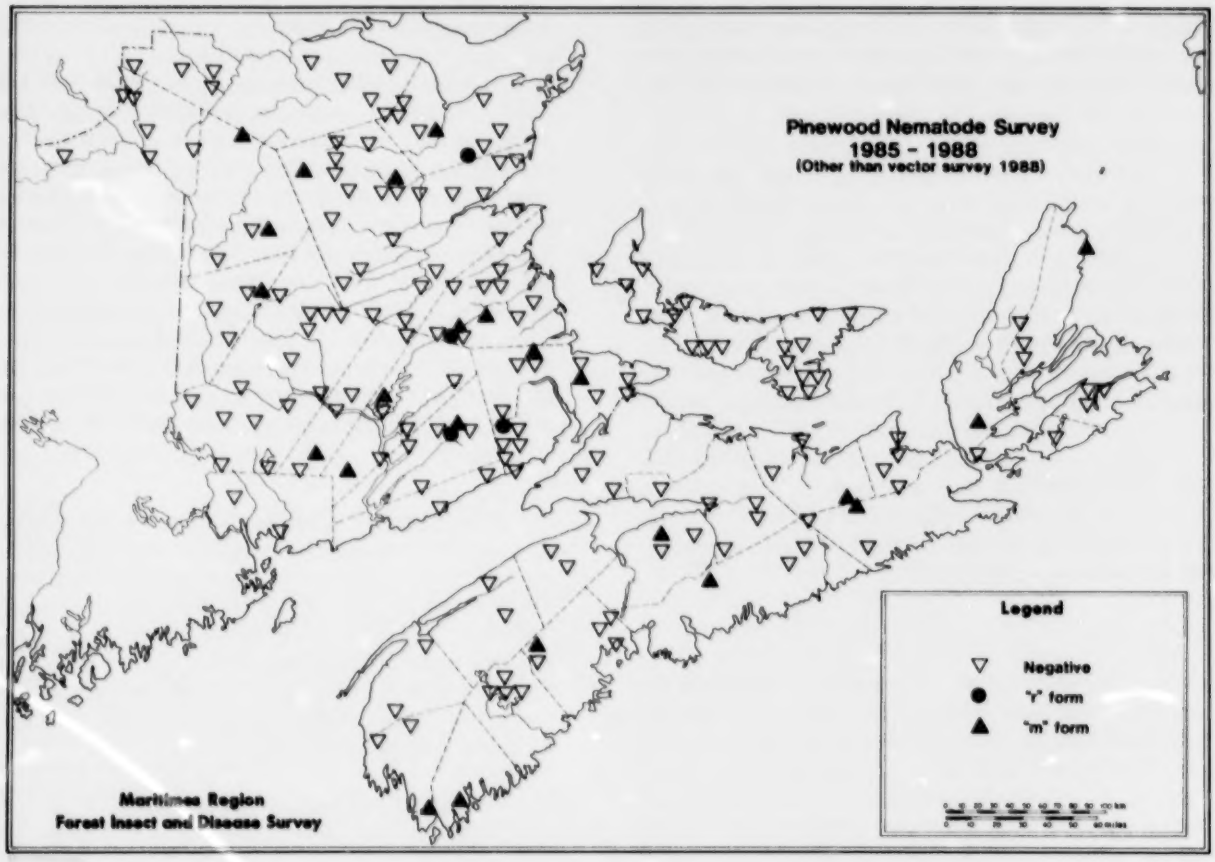


Figure 9

There is no evidence to justify the pinewood nematode in the Maritimes as an organism of biologically significant importance to forest health (i.e. a tree killer), but the consequences of its presence may be economically significant as it may affect our ability to export forest products, such as wood chips, because of plant quarantine related regulations in other countries.

Vector survey - 1988

During the summer of 1988, a special pinewood nematode-vector survey was conducted in the Maritimes as part of a national effort. The purpose of the survey was to clarify the situation regarding wood inhabiting insects as possible vectors of the pinewood nematode, a problem which threatens the Canadian lumber exports to Europe, a potential loss of more than $300 million annually.

Sampling wa done according to an established national protocol to ensure uniformity across Canada. Insects were collected in the forest, on slash or on log piles in cut-over areas, on logs, bark- and chip-piles in mill yards, and even "on freshly hung laundry on a backyard clothesline". Most insects were picked up while resting, others were trapped in bottles baited with attractants, and some, mainly bark beetles, were reared in the laboratory from infested logs. Although most of the sampling was done by Forest Insect and Disease Survey personnel, many samples were submitted by staff of provincial forestry services, mills, industrial companies, some municipalities, and by some interested private individuals.

Although most samples consisted of single collections at particular locations, a special effort was expended on repeated collecting in the Nevers

Table 11. Summary of pinewood nematode surveys in the Maritimes Region in 1985 - 1988

Sampling variables	Maritimes Region	New Brunswick	Nova Scotia	Prince Edward Island
No. of locations sampled	228	147	55	26
Tree species		Number of samples		
Balsam fir	178	107	58	13
Jack pine	47	47	-	-
Red pine	13	6	6	1
Scots pine	18	12	5	1
White pine (eastern)	41	18	19	4
Black spruce	53	21	29	3
Red spruce	16	8	8	-
Sitka spruce	1	-	-	1
White spruce	50	14	6	30
Larch	1	-	-	1
Total number of trees sampled	418	233	131	54
Insects sampled (excluding 1988 vector survey)		Number of insects collected		
Sawyer beetle (*Monochamus* sp.)	26	25	1	-
Seedling debarking weevil (*Hylobius* sp.)	23	7	16	-
Total number of insects sampled	49	32	17	-
Total number of samples (trees and insects)	467	265	148	54

Table 12. Summary of the pinewood nematode vector survey in the Maritimes Region in 1988

Sampling variables	Maritimes Region	New Brunswick	Nova Scotia	Prince Edward Island
No. of locations sampled	151	76	69	6
No. of samples submitted	260	150	99	11
Insect species	Number of insects collected			
Cerambycidae				
Acmaeops proteus	1	1	0	0
Anoplodera brevifrons	1	1	0	0
Anoplodera canadensis	3	2	1	0
Anoplodera chrysocoma	1	0	0	0
Anoplodera nigrella	1	1	0	0
Anoplodera sp.	2	2	0	0
Arhopalus foveicollis	1	1	0	0
Asemum striatum	3	3	0	0
Bellamira scalaris	1	1	0	0
Graphisurus sp.	1	1	0	0
Monochamus notatus	2	0	2	0
Monochamus scutellatus	267	246	20	1
Monochamus titillator	3	3	0	0
Monochamus sp.	2	0	2	0
Saperda calcarta	1	1	0	0
Xylotrechus undulatus	3	0	3	0
Buprestidae				
Buprestis maculativentris	5	5	0	0
Chrysobothris dentipes	3	3	0	0
Chrysobothris scabripennis	9	4	5	0
Chrysobothris sp.	21	41	6	1
Dicerca tenebrosa	4	3	1	0
Dicerca sp.	26	4	22	0
Melanophila sp.	6	1	2	3
Poecilnota cyanipes	1	0	1	0
Scolytidae				
Dendroctonus rufipennis	151	0	151	0
Dendroctonus simplex	28	19	0	9
Dryocoetes affaber	5	5	0	0
Ips borealis	650	20	610	20
Orthotomicus caelatus	18	3	15	0
Pityophthorus sp.	17	0	17	0
Pityokteines sparsus	98	87	11	0
Polygraphus rufipennis	274	31	243	0
Trypodendron sp.	28	27	1	0
Scolytidae (others)	6	0	6	0
Curculionidae				
Hylobius congener	9	2	7	0
Pissodes dubius	8	8	0	0

Table 12. (Continued)

Sampling variables	Maritimes Region	New Brunswick	Nova Scotia	Prince Edward Island
No. of locations sampled	151	76	69	6
No. of samples submitted	260	150	99	11
Insect species	Number of insects collected			
Melandryidae				
Serropalpus barbatus	2	2	0	0
Siricidae				
Sirex sp.	3	0	3	0
Urocerus sp.	11	6	5	0
Totals	1676	498	1144	34

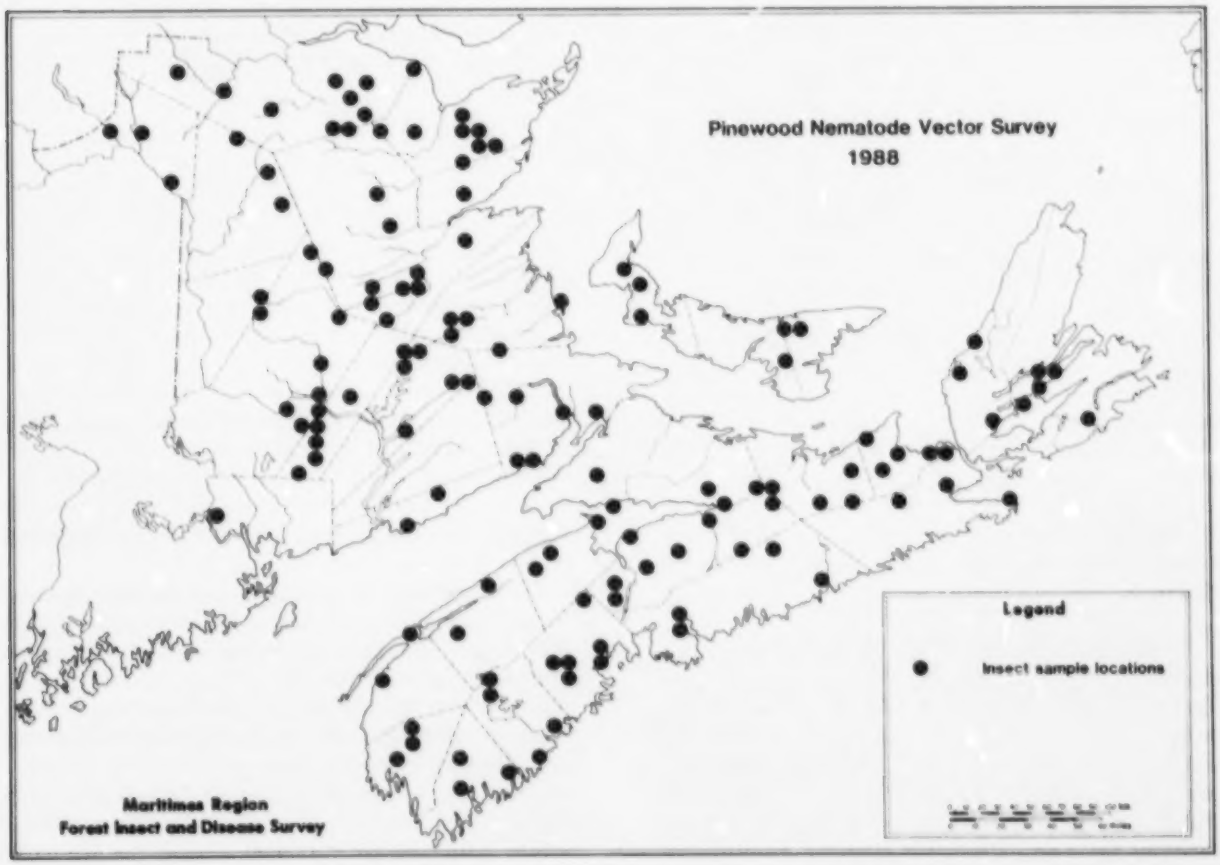


Figure 10.

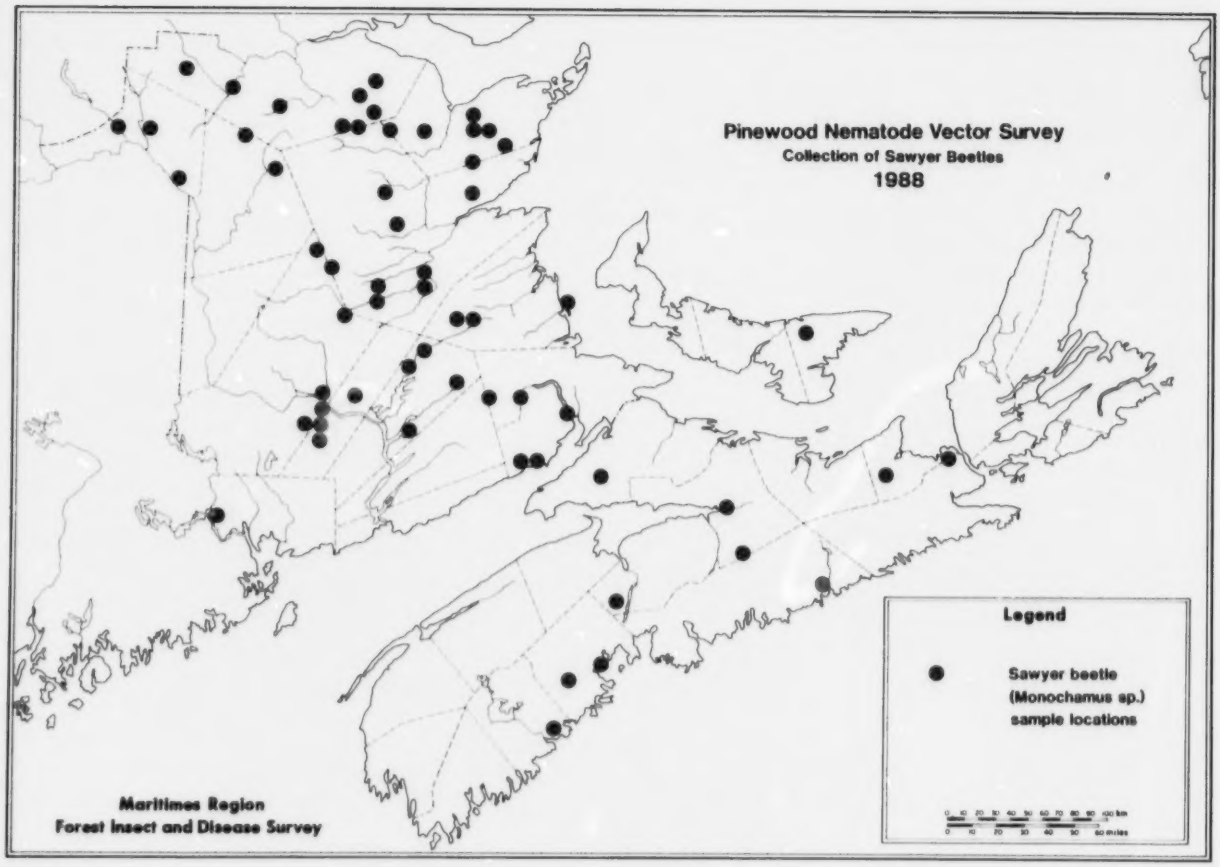


Figure 11

Brook, Kent County, N.B., area, where the "r" form of the pinewood nematode was found both in 1986 and 1987, even though in only a very few trees.

Specimens were shipped by air to ensure that they arrived alive at Memorial University, St. John's, Newfoundland, for preparation and identification.

The pinewood nematode vector survey in the Maritimes in 1988 yielded 1676 specimens, representing 38 insect species in 6 families. The various insects and their numbers submitted in 260 collections are listed in Table 12, the distribution of the 151 locations is shown in Fig. 10. Collection points for the various species of sawyer beetles (*Monochamus* sp.), the "chief suspect" among possible vectors of the pinewood nematode are shown in Fig. 11.

Results of identifications are not yet available but are expected some time in 1989.

FOREST PEST ASSESSMENTS IN PLANTATIONS

The increasing importance of planted trees in forest management resulted in the initiation of an annual plantation assessment program in 1982. The lessons learned from agriculture and from experience with large-scale forest plantings suggest that tracts of even-aged, single species forests will bring with them special pest problems. Previously insignificant pests may take on new importance and many of the well-known pests may change their habits in the new environment. Among these are the spruce budmoth, Sirococcus shoot blight, Armillaria root rot, needle rust on jack pine, and seedling

debarking weevil, which are described in some detail in other chapters of this report. As our knowledge of pest outbreaks in plantations accumulates, our methods of establishing and tending plantations must incorporate ways to offset the effects of such pests, if we wish to avoid or minimize losses.

Our plantation surveys attempt to determine the status of all significant insects and diseases. The plan was to assess at least one host species each year in selected plantations throughout the Maritimes to obtain a general picture of pest problems. This was to indicate the need for detailed surveys of plantations in specific areas in cooperation with clients. Although plantation selection is random, new plantations were initially avoided to eliminate problems associated with site selection and establishment techniques.

We (FIDS) have not conducted large-scale, specific, systematic plantation surveys since 1984 due to other work priorities. However, numerous plantations have been visited and observations were made. The results of these have been reported as appropriate.

The realization of the importance of forest pests to the future wood supply in New Brunswick resulted, in 1985, in the first large-scale joint plantation survey between the provincial Department of Natural Resources and the Forest Insect and Disease Survey of Forestry Canada - Maritimes to assess the general state of health of plantations and of silviculturally-treated (thinned) areas. There were large-scale joint surveys conducted in response to crisis situations, such as the Scleroderris survey in 1979, in the wake of the discovery of the European race of that disease in the Province. The survey in 1985 was conducted as a pilot project in anticipation of regular, continuing surveys in future years. In 1986, the Department of Natural Resources and the Forest Insect and Disease Survey were joined by two of New Brunswick's larger forest companies, J.D. Irving Ltd. (JDI), and Fraser Inc. (Fras), in carrying out extensive pest assessment surveys in plantations. To ensure uniformity and standardization, both classroom and field instruction courses were conducted in advance of the actual field work. The surveys were expanded in 1987 and Consolidated Bathurst Inc. (CBI) and NBIP Forest Products Inc. (NBIP) from New Brunswick and Nova Scotia Department of Lands and Forests (NSLF), Bowater-Mersey Ltd. (B-M), and Stora Forest Industries Ltd. (Stora) joined this cooperative undertaking.

In 1988, the plantation assessment surveys became truly regional for the first time with the involvement of the Prince Edward Island Dept. of Energy and Forestry. Canadian Pacific Forest Products Ltd-Miramichi Division (CPFP) in New Brunswick also participated for the first time.

There were 268 plantations assessed by the various organizations, 188 in New Brunswick (Table 13), 71 in Nova Scotia (Table 14), and 9 in Prince Edward Island (Table 15). DNR also assessed 11 thinned areas (Table 16). Observations were made on the type and level of forest pest-caused disturbances or damage. Field assessments were carried out by staff of the various organizations. Identification of samples and summarizing were done by the Forest Insect and Disease Survey. Analysis of data is in progress and details will be reported at a later date. Involvement in organized pest surveys of this type being a new undertaking, some companies viewed 1988 as a pilot year and limited the number of assessments accordingly.

There were 376 assessments made in the 279 areas surveyed, 35% of the plantations or thinned areas having been visited twice during the season. A total of 18 800 trees were examined in the course of the surveys.

A few brief comments on some of the results follow. Detailed information will be presented elsewhere (readers should be aware of the differences in the numbers of plantations assessed in the three provinces when looking at percentage figures). Late-arriving assessment forms were not considered for some of the figures mentioned.

1. In the Maritimes, over 90% of the almost 19 000 trees assessed were classified as healthy (Table 17).

2. Tree condition in the thinned areas in New Brunswick was marginally worse than in plantations but no tree mortality was reported from any of the 11 areas.

3. Even though most trees were classified as healthy, there were at least some trees with severe damage in 39% of the plantations surveyed in New Brunswick, 45% in Nova Scotia, and 44% in Prince Edward Island (Table 18).

4. There was no difference, on a regional basis, between pine and spruce plantations with regard to the occurrence of severely damaged trees, as 41% of the plantations of each species had at least some severely affected trees.

The various plantation problems encountered at severe or moderate damage levels are listed in Table 19 for New Brunswick, Table 20 for Nova Scotia and Table 21 for Prince Edward Island.

Table 13. Summary of plantation assessments by tree species and organization conducting field work in the various resource management regions in New Brunswick in 1988

Region	Tree species	Total plantations assessed	Organization				
			DNR	CBI	Fras	JDI	CPFP
1	Black spruce	17	3	-	6	8	-
	White spruce	2	-	2	-	-	-
	Spruce (unspec)	5	5	-	-	-	-
	Jack pine	8	6	-	1	1	-
	Mixed species	4	3	-	1	-	-
Total for Region		36	17	2	8	9	0
2	Black spruce	3	3	-	-	-	-
	White spruce	1	1	-	-	-	-
	Jack pine	6	6	-	-	-	-
Total for Region		10	10	0	0	0	0
3	Black spruce	7	7	-	-	-	-
	White spruce	7	-	7	-	-	-
	Spruce (unspec)	3	3	-	-	-	-
	Jack pine	29	15	14	-	-	-
Total for Region		46	25	21	0	0	0
4	Black spruce	11	10	-	-	-	1
	White spruce	6	6	-	-	-	-
	Spruce (unspec)	1	1	-	-	-	-
	Jack pine	3	2	-	-	-	1
	Red pine	3	2	-	-	-	1
	Larch	1	1	-	-	-	-
	Mixed	1	1	-	-	-	-
Total for Region		26	23	0	0	0	3
5	Black spruce	44	4	17	23	-	-
	White spruce	24	5	15	4	-	-
	Red pine	1	-	-	1	-	-
	Larch	1	-	-	1	-	-
Total for Region		70	9	32	29	0	0
Total for New Brunswick		188	84	55	37	9	3

Table 14. Summary of plantation assessments by tree species and organization conducting field work in the various resource management regions in Nova Scotia in 1988.

For. Manag. Area	Tree species	Total plantations assessed	Organization		
			NSLF	Stora	FIDS
Western	Red spruce	4	4	-	-
	Red pine	3	3	-	-
	White pine	1	1	-	-
Total for Region		8	8	0	0
Valley	Red spruce	4	4	-	-
	Spruce (Unsp)	2	2	-	-
	White pine	1	1	-	-
	Mixed	1	1	-	-
Total for Region		8	8	0	0
S. Shore	Norway spruce	1	1	-	-
	Red pine	3	2	-	1
Total for Region		4	3	0	1
N. Central	Red spruce	1	-	-	1
	Red pine	9	8	-	1
	Unsp.	1	1	-	-
Total for Region		11	9	0	2
S. Central	Black spruce	1	1	-	-
	Red spruce	1	1	-	-
	Red pine	4	4	-	-
	Mixed	1	1	-	-
Total for Region		7	7	0	0
Eastern	Black spruce	7	2	4	1
	Red spruce	5	-	5	-
	Norway spruce	3	1	2	-
	White spruce	1	1	-	-
	Jack pine	1	1	-	-
	Mixed	1	1	-	-
Total for Region		18	6	11	1
Cape Breton	Black spruce	9	1	8	-
	Norway spruce	2	2	-	-
	White spruce	2	-	2	-
	Mixed	2	-	2	-
Total for Region		15	3	12	0
Total for Nova Scotia		71	44	23	4

Table 15. Summary of plantation assessments by tree species, conducted by the Prince Edward Island Forest Service in the various resource management regions in 1988

For. Manag. Area	Tree species	Total plantations assessed
Western	Black spruce	3
	Larch	2
Total for Region		5
Central	Black spruce	1
	Red pine	1
Total for Region		2
Eastern	Red pine	2
Total for Region		2
Total for Prince Edward Island		9

Table 16. Summary of thinned areas assessed in the various Forest Management Regions by DNR personnel in New Brunswick in 1988

Stand composition	Total assessed	Distribution by DNR Region				
		1	2	3	4	5
Black spruce	1			1		
Balsam fir	3				1	2
Mixed	11	1	3	1	4	2
Total	15	1	3	2	5	4

Table 17. The condition of trees in plantations in the Maritimes in 1988

Province	Species	Trees in various condition categories (%)			
		Healthy	Fair	Poor	Dead
N.B.	Pine	92.7	4.9	1.7	0.7
	Spruce	93.2	4.8	1.2	0.8
	Other	89.6	6.8	2.3	1.3
N.S.	Pine	93.4	4.9	1.5	0.2
	Spruce	90.4	7.2	1.4	1.0
	Other	81.2	14.4	3.6	0.8
P.E.I.	Pine	88.5	10.5	1.0	0.0
	Spruce	88.3	8.7	3.0	0.0
	Other	77.0	23.0	0.0	0.0

Table 18. Plantations with at least some incidence of severe or moderate damage in the Maritimes in 1988

Province	Species	Number of plantations		
		Assessed	With damage	
			Mod.	Sev.
N.B.	Pine	50	9	17
	Spruce	131	31	54
	Other	7	2	2
N.S.	Pine	21	4	11
	Spruce	36	13	16
	Other	5	1	1
P.E.I.	Pine	3	1	2
	Spruce	4	2	1
	Other	2	1	1

Table 19. Problems observed at the severe or moderate level during plantation pest assessment surveys in New Brunswick in 1988

Plantation problems	Number of plantations with problems in various DNR regions														
	Pine					Spruce					Other				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Abiotic injuries	1	-	1	4	-	5	1	2	3	13	1	-	-	1	1
Animal damage	-	-	5	1	1	1	-	-	2	4	-	-	-	-	-
Armillaria root rot	-	2	1	3	-	2	1	2	3	16	-	-	-	-	-
Blister rust	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Budmoth(s)	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
Budworm(s)	-	-	-	-	-	9	-	3	-	7	-	-	-	-	-
Competition-Hardwood	-	-	-	-	-	-	-	-	-	4	-	-	-	1	-
Herbaceous	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Unspecified	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Conifer aphids	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-
Faulty planting	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Frost damage	-	-	-	-	1	6	1	-	1	24	-	-	-	1	1
Globose gall rust	-	1	5	-	-	-	-	-	-	-	-	-	-	-	-
Mites	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Needle rust	1	1	3	-	-	-	-	-	-	-	-	-	-	-	-
Northern pitch twig moth	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Snow damage	1	-	2	2	1	1	-	2	1	3	1	-	-	-	1
Spruce bud midge	-	-	-	-	-	1	-	-	-	8	-	-	-	1	-
Spruce gall adelgid	-	-	-	-	-	1	1	2	2	7	-	-	-	-	-
Spruce gall midge	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-
White pine weevil	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Winter drying	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-
Misc. problems	2	-	-	-	-	2	-	-	-	1	-	-	-	-	-

Table 20. Problems observed at the severe or moderate level during plantation pest assessment surveys in Nova Scotia in 1988

Plantation problems	Number of plantations with problems in the various NSLF subdivisions																						
	Pine							Spruce							Other								
	W	SS	V	NC	SC	E	CB	W	SS	V	NC	SC	E	CB	W	SS	V	NC	SC	E	CB		
Abiotic injuries	1	1	-	-	3	-	-	1	-	2	-	2	3	4	-	-	1	-	-	-	1		
Animal damage	2	-	-	4	1	1	-	1	-	-	-	2	2	-	-	-	-	-	-	-	-		
Armillaria root rot	-	-	-	-	1	-	-	-	-	-	1	-	-	3	-	-	-	-	-	-	-		
Budworm(s)	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-		
European pine shoot moth	-	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Faulty planting	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1		
Frost damage	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-		
Hardwood competition	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-		
Herbaceous competition	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-		
Mites	-	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-		
Needle rust	-	-	-	4	1	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-		
Root collar weevil	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-		
Sirococcus shoot blight	-	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-		
Snow damage	-	-	-	3	1	-	-	-	-	1	1	-	1	4	-	-	-	-	-	-	1		
Spruce bud midge	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-		
Spruce gall adelgid	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-		
Spruce twig aphid	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-		
White pine weevil	1	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-		
Winter drying	-	1	-	1	-	-	-	-	1	2	1	-	1	1	-	-	-	-	-	-	-		
Misc. problems	1	-	-	-	-	1	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-		

W=western; SS=South Shore; V=Valley; NC=North Central; SC=South Central; E=Eastern; CB=Cape Breton

Table 21. Problems observed during plantation pest assessment surveyed in Prince Edward Island in 1988

Plantation problem	Pine			Spruce			Other		
	W	C	E	W	C	E	W	C	E
Animal damage	-	-	-	-	-	-	1	-	-
European pine sawfly	-	-	1	-	-	-	-	-	-
European pine shootmoth	-	1	2	-	-	-	-	-	-
Frost	-	-	-	-	-	1	-	-	-
Larch casebearer	-	-	-	-	-	-	2	-	-
Orange spruce needleminer	-	-	-	-	1	-	-	-	-
Snow damage	-	1	2	1	1	-	1	-	-
Spruce bud midge	-	-	-	1	-	-	-	-	-
Spruce budworm	-	-	-	-	1	-	-	-	-
Winter drying	-	-	-	-	-	1	-	-	-
Yellow headed spruce sawfly	-	-	-	-	2	-	-	-	-
Misc. problems	-	-	-	1	-	-	-	-	-

W=Western; C=Central; E=Eastern

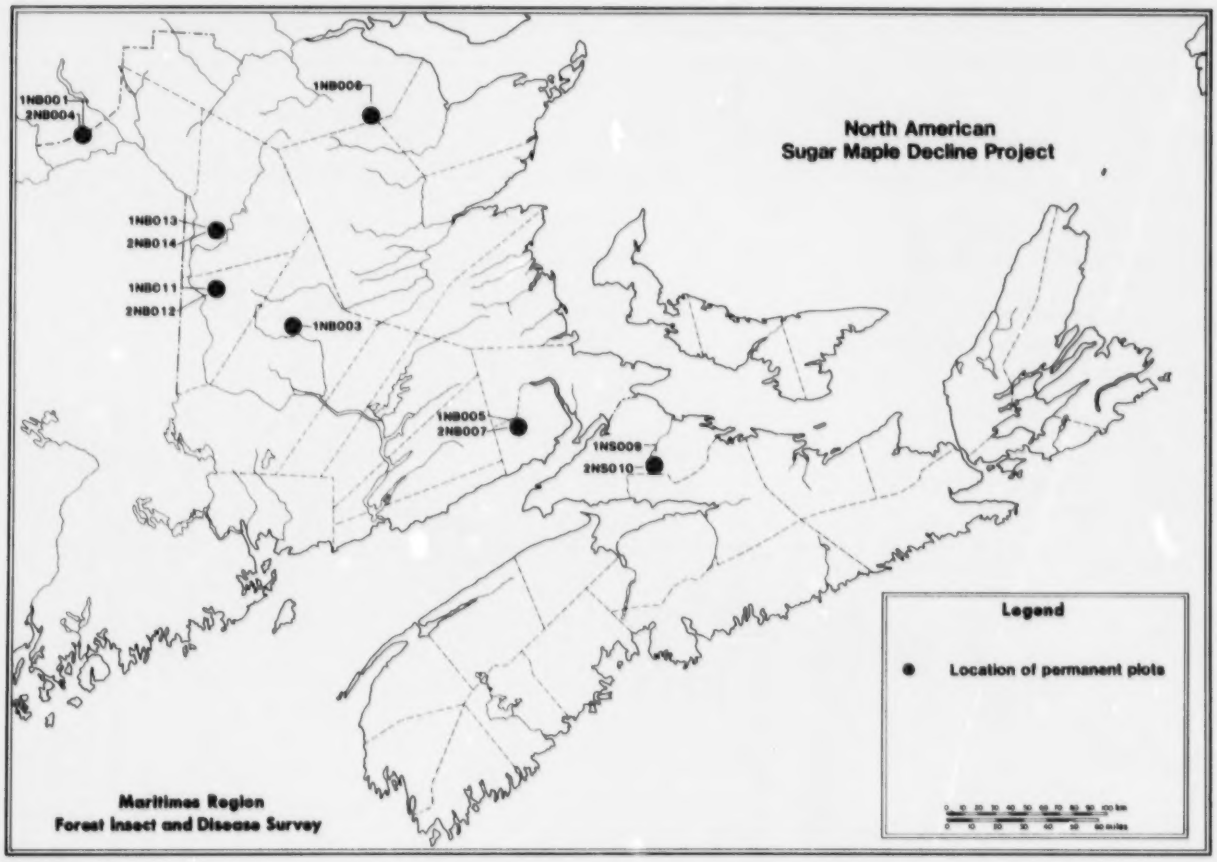


Figure 12

SUGAR MAPLE DECLINE

Much has been said and written in recent years about the sugar maple decline affecting vast areas of eastern North America, especially Quebec, and about its effects on the maple syrup industry and other forestry related activities. The reasons for this decline are still not known in spite of the large, international research effort undertaken to determine the cause. Maple dieback, as it is often known, appears to be associated, at least in some instances, with the deterioration of other hardwoods.

In New Brunswick, in 1986, surveys identified some sugar maple stands in deteriorating condition but no widespread decline was found. In 1987, an aerial survey was conducted over much of the Province, covering parts of York, Carleton, Victoria and Madawaska counties, to gain a better overview of where declining stands may exist. This area was selected partly to follow up on results of the 1986 survey, and partly because of its proximity to Quebec and the northeastern United States. The survey was a cooperative effort of the Forest Insect and Disease Survey and the New Brunswick Departments of Natural Resources and Municipal Affairs and Environment.

Decline in stands of sugar maple exists in some parts of New Brunswick; however, as reported in 1987, the pattern of the deterioration is discontinuous, of variable intensity, and its cause is often known or is explainable.

The North American Sugar Maple Decline Project, a major international, interprovincial program, was launched in 1988. It was designed to help understand the possible causes of maple decline in eastern North America. A joint program of Canada and the United States, the project involves four eastern provinces and seven eastern states, with workers from federal, provincial, and state agencies,

as well as from universities. The objectives are (1) to examine change in sugar maple condition over a large geographical area and (2) to relate change, if possible, to levels of atmospheric pollution. Assessments include both managed sugar bushes and unmanaged stands at various levels of initial stand condition. Over 100 plots were established in the United States and over 60 plots in Canada.

In the Maritimes, 10 permanent plots were established in New Brunswick and 2 in Nova Scotia (Fig. 12). All plots were assessed according to standardized protocol and the information was submitted to a central data bank for analysis. Assessments were a cooperative effort of personnel from Forestry Canada - Maritimes, New Brunswick Dept. of Natural Resources, New Brunswick Dept. of Municipal Affairs and Environment, and the Nova Scotia Dept. of Agriculture and Marketing. Data is not yet available.

PHEROMONE TRAPPING SURVEYS

Pheromones are chemical substances released by insects to communicate with another insect of the same species. In the case of sex pheromones, the female attracts males for the purpose of mating. Other forms of chemical communication include host attractants and aggregation pheromones. Collectively, these are called "semiochemicals". Researchers take advantage of these communication systems to detect, monitor, and predict populations of insects by luring the target pest into traps and counting the moths caught.

In the Maritimes, the Forest Insect and Disease Survey has been using pheromones as survey tools since 1971 when traps were first used in detection surveys for the gypsy moth. The effort has gradually increased since then and, in 1988, there were 11 insects for which pheromones were used in some manner. New lures are often tested in cooperation with researchers. If proven reliable in attracting insects, a period of calibration follows, which "gives meaning" to the numbers caught by a specific trap. Although much of the trapping and associated observations are carried out by our own personnel, considerable cooperation is forthcoming from provincial and industrial personnel and from other groups within Forestry Canada. Their assistance and the cooperation of researchers is acknowledged.

In 1988, pheromones or attractants were used for a number of insects. Comments on each follow:

Spruce budworm - As part of an inter-regional and international testing program to determine the reliability of traps and pheromones in monitoring annual population changes of the spruce budworm, the system was tested at 35 locations in the Maritimes in 1988. Cooperating in the program were the New Brunswick Department of Natural Resources (10 locations), the Nova Scotia Department of Lands and Forests (2 locations), J.D. Irving Ltd. (3 locations), E.G. Kettela of Forestry Canada - Maritimes (10 locations), and the regional Forest Insect and Disease Survey (10 locations).

Multi-pher traps, baited with PVC pellets, were used in a cluster of three traps deployed at each location. Trees at most of these locations were sampled in the early summer to determine spruce budworm larval populations at the L3-L4 stage; adult males captured by the traps were counted at the end of the flight period; defoliation levels on the sample trees were determined; and L2 counts, an indicator of next year's expected population levels, were obtained. The results of the various counts are summarized in Table 22. Where available, the L2 counts from 1987 are included for comparison.

This information becomes part of the common database to be analyzed for relationships before the system can become an operational tool. This was the fourth and last year of the program in its present form. Further research will be necessary before the resumption of large-scale testing.

Forest tent caterpillar - Trap capture was very low in 1988 (Fig. 13), which corresponds with the low populations of the insect and the lack of defoliation observed. Results also suggest that there will be no defoliation by the forest tent caterpillar in the Maritimes in 1989.

Change in catch success and in the number of traps employed follow:

1984	60% positive (158 traps)
1985	40% positive (98 traps)
1986	12% positive (78 traps)
1987	1% positive (76 traps)
1988	7% positive (59 traps)

Table 22. Spruce budworm pheromone trapping in the Maritimes Region in 1988

Location	UTM Grid	Host	1987 L2	1988 L3 - L4	1988 Pheromone catch 1	2	3	Ave	1988 Defol. Vis. est %	1988 L2	Co-Op Agency
				larv/10 m²						larv/10 m²	
New Brunswick											
East Branch Canaan River Westmorland Co. DNRE #10	20-33(5)-512(0)	S b/r	30.7	--	69	35	94	66.0	20.8	5.3	D.N.R.
Parkindale Seed Orchard Station #1, Albert Co.	20-33(9)-508(2)	bF	0.0	0.0	0	0	0	0.0	5.0	0.0	J.D.I.
Allardville East Gloucester Co. DNRE #4	20-31(4)-526(2)	bF	0.7	--	2	10	6	6.0	13.0	7	D.N.R.
Sussex Tree Nursery, Kings Co.	20-31(8)-506(8)	wS	--	0.0	0	1	1	0.7	--	-	J.D.I.
W of Despres Lake Northumberland Co.	20-30(1)-516(9)	F S	5.0	0	0	0	0	0.0	0	-	C.F.S.
Forks Stream Queens Co. DNRE #9	20-30(2)-510(8)	S b/r	1.6	--	0	0	0	0.0	5.0	0	D.N.R.
SE of South Lake Northumberland Co.	20-29(9)-516(9)	F S	2.0	0	0	0	0	0	0	-	C.F.S.
S of East Branch Sabbies River, Northumberland Co.	20-29(2)-515(8)	F S	0	0	2	1	3	2	0	-	C.F.S.
Shinnickburn Rd SE of Upper Blackville Bridge, Northumberland Co. DNRE #5	20-28(1)-516(5)	bS	0.0	--	0	0	0	0.0	5.0	0.3	D.N.R.
West Branch Sabbies River, Northumberland Co.	20-28(9)-515(5)	F S	0.0 0.0	0	0	0	1	0.3	0	-	C.F.S.
SW of Pineville Northumberland Co.	20-27(5)-518(4)	F S	0.0	1.0	1	0	0	0.3	0	-	C.F.S.

Table 22. (Continued)

Location	UTM Grid	Host	1987 L2	1988 L3 - L4	1988 Pheromone catch 1	2	3	Ave	1988 Defol. Vis. est %	1988 L2	Co-Op Agency
				larv/10 m²						larv/10 m²	
Bartholomew Northumberland Co. DNRE #6	20-27(7)-517(7)	bF	1.6	--	0	0	0	0.0	7.0	0	D.N.R.
Bartholomew Northumberland Co.	20-27(2)-517(7)	F S	0.0 3.0	--	0	0	0	0	0	-	C.F.S.
W of Upper Blackville, Northumberland Co.	20-27(5)-516(7)	F S	4.0	--	0	0	1	0.3	0	-	C.F.S.
W of Shinnickburn Northumberland Co.	20-27(6)-515(9)	F	6.0	--	1	35	0	12.0	0	-	C.F.S.
S of Tetagouche, W of; Restigouche Co.	19-71(7)-527(4)	bF	7.3	1219.6	69	31	101	67	4.0	2.6	F.I.D.S.
Pleasant Valley York Co. DNRE #7	19-68(7)-511(9)	S b/r	1.3	--	0	0	0	0.0	5.0	0.0	D.N.R.
Popelogan Lake, W of; Restigouche Co. DNRE #3	19-67(1)-529(7)	bF	18.0	--	4	35	13	17.3	54.1	1.3	D.N.R.
Mountain Road, Mazerolle Settlement, York Co.	19-66(4)-507(9)	bF	0.7	0.0	0	0	0	0.0	0.0	2.0	F.I.D.S.
Juniper Tree Nursery, Carleton Co.	19-64(2)-515(7)	bF	0.3	0.0	-	-	-	-	--	-	J.D.I.
Deersdale, York Co, DNRE #8	19-64(9)-514(8)	S b/r	0.3	--	0	0	0	0.0	5.0	0.0	D.N.R.
Gulguac River Victoria Co. DNRE #1	19-63(8)-520(2)	bF	4.3	--	0	0	0	0.0	5.0	0.0	D.N.R.
Plaster Rock-Renous Hwy., Little Wapske Rd, Northumberland Co.	19-63(7)-519(6)	bF	2.0	13.46	0	0	0	0.0	0.0	0.0	F.I.D.S.

Table 22. (Continued)

Location	UTM Grid	Host	1987	1988							Co-Op Agency
			L2	L3 - L4	Pheromone catch				Defol. Vis. est %	L2	
				larv/10 m²	1	2	3	Ave		larv/10 m²	
Boston Brook Airstrip, Victoria Co.	19-60(4)-525(3)	F S	11.0	4.1	53	100	71	74.6	<5	-	C.F.S.
Veneer Siding Gate, Victoria Co.	19-59(7)-524(0)	F S	8.0	3.1	15	10	42	22.3	15	-	C.F.S.
Kedgwick Forks Restigouche Co. DNRE #2	19-58(3)-530(3)	bF		39.7	--	41	Traps torn down		72.2	5	D.N.R.
Nova Scotia											
Mile 20, Highland Road, Victoria Co.	20-66(9)-514(0)	bF	0.0	0.0	0	0	0	0.0	5.0	0	F.I.D.S.
Mile 4, Highland Road, Victoria Co.	20-66(6)-511(5)	bF	0.0	0.0	0	0	0	0.0	5.0	0	F.I.D.S.
S Cape Breton Highlands, Inverness Co.	20-62(4)-511(1)	bF	0.0	0.0	0	0	0	0.0	5.0	0	F.I.D.S.
Twin Lake on Third Lake Road Guysborough Co.	20-58(1)-501(0)	bF	0.0	0.0	0	0	0	0.0	5.0	0	F.I.D.S.
Lynn Mountain Cumberland Co.	20-41(5)-503(5)	rS	--	--	3	1	0	1.3	31.0	0.3	N.S.L.F.
Diligent River Cumberland Co.	20-38(6)-502(8)	bF	0.0	--	0	0	0	0.0	47.0	0	N.S.L.F.
Woodville, NE of Ross Corner, Kings Co.	20-37(1)-500(0)	bF wS	0.0	0.0	0	0	0	0.0	5.0	0	F.I.D.S.
Sand Lake, Queens Co.	20-32(1)-490(2)	bF	1.6	0.0	0	0	0	0.0	5.0	0	F.I.D.S.
Prince Edward Island											
Valleyfield, Kings Co.	20-52(1)-510(9)	wS	13.3	1800	11	27	14	17.3	10.0	10.3	F.I.D.S.

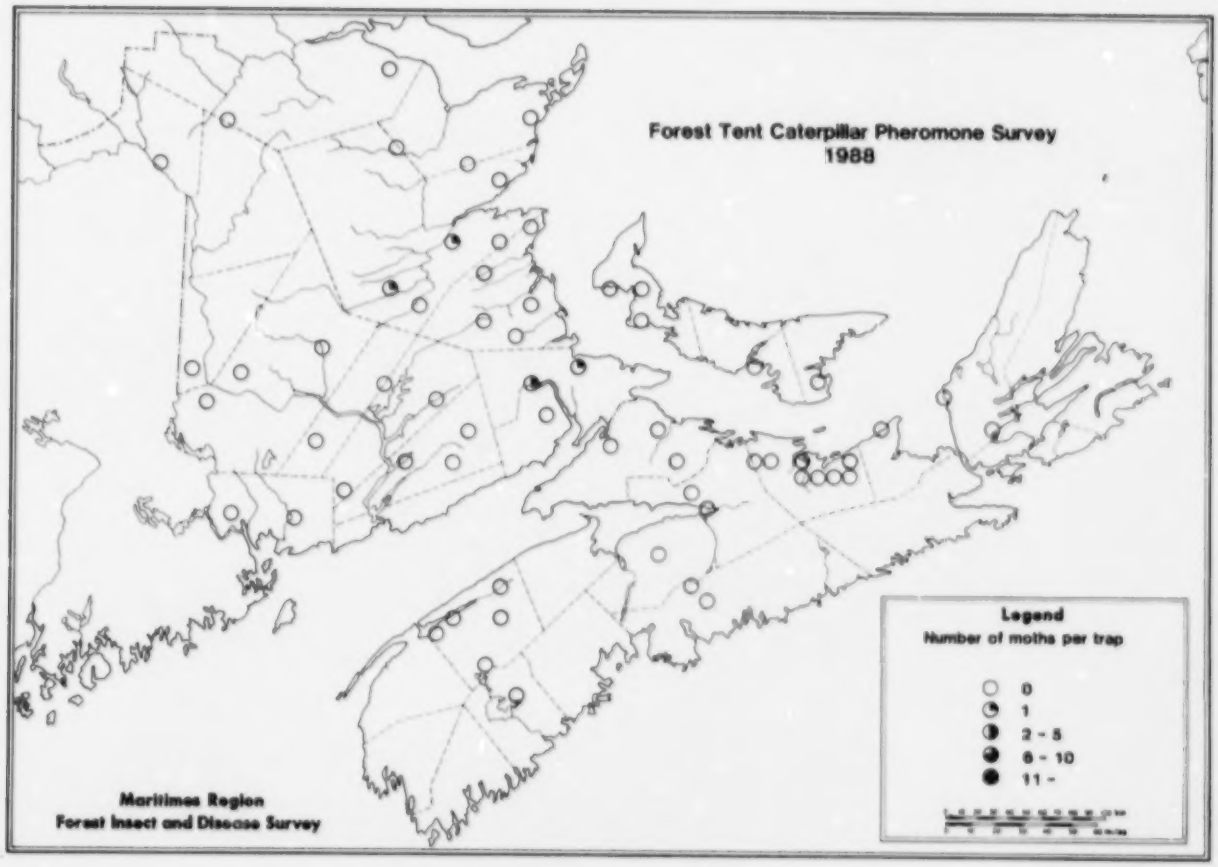


Figure 13

During periods of low insect populations, the intensity of surveys may be safely reduced (as indicated by the decreasing number of traps employed) without danger of failing to detect a turn-around in population trends. Should forest tent caterpillar catches increase - either in terms of numbers caught per trap or in terms of wider population spread - the number of traps will be increased and other survey methods (such as egg mass surveys) will be considered to obtain more precise measures of population changes.

Jack pine budworm - Trap captures were very low in most Maritime locations in 1988 (Fig. 14), consistent with the trace to negative levels of defoliation observed. Most Nova Scotia locations were negative, as has previously been the case in this province where jack pine is a minor forest component. Small populations exist in localized patches in eastern New Brunswick. The pattern of trap captures over the last few years does not suggest that an outbreak is likely in the near future. The changes in the percent of positive locations and the number of trap locations over the last five years follow:

1984	72% positive (67 traps)
1985	84% positive (64 traps)
1986	60% positive (64 traps)
1987	49% positive (53 traps)
1988	35% positive (52 traps)

European pine shoot moth - Trapping indicates continuing low numbers at most locations (Fig. 15). The exception was on Prince Edward Island where catches were high at North Granville, Queens County (6 moths/trap) and Valleyfield, Kings County (8 moths/trap). The number of trapping locations was increased to 29 during 1988, from 14 in 1987, in order to give better coverage.

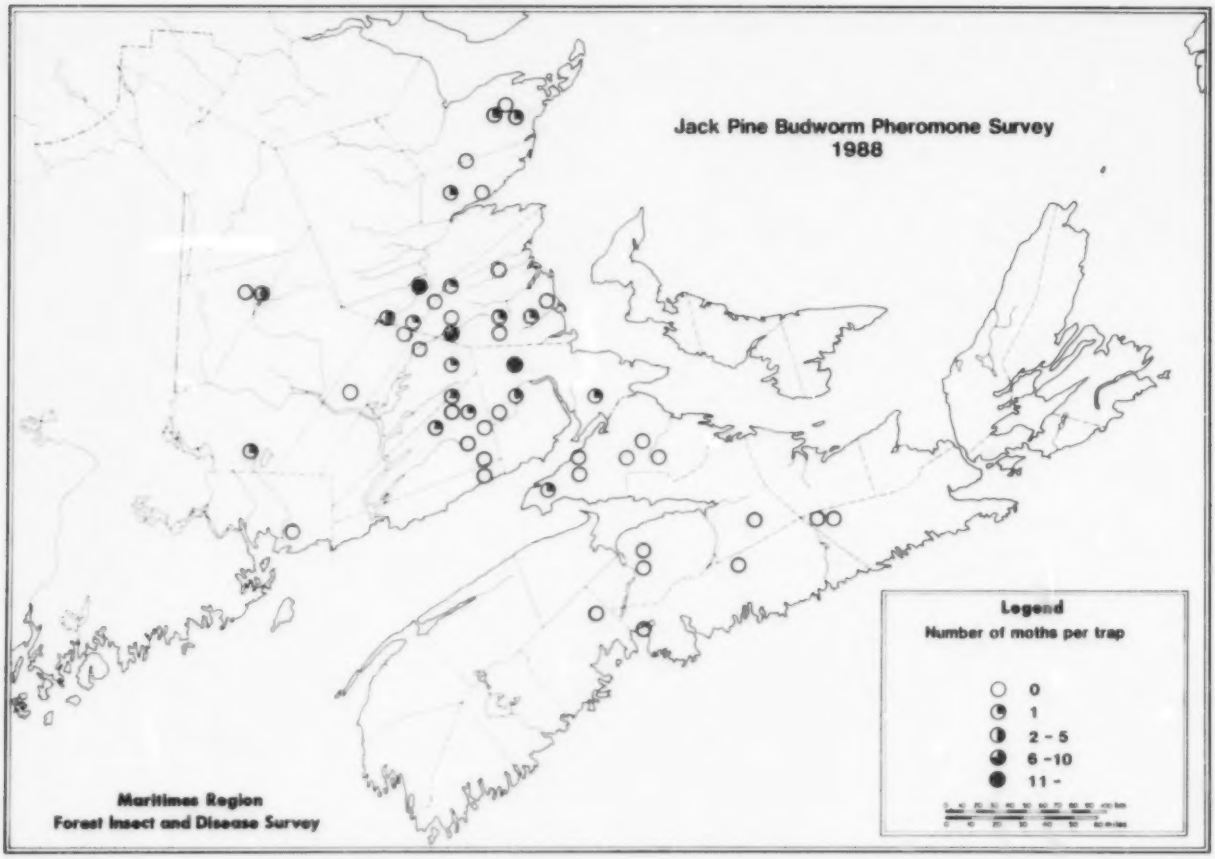


Figure 14

Oak leaf shredder - Trap catches were consistent with those of previous years and indicate that damaging levels of insect populations exist in many areas (Fig. 16). Oak leaf shredder often occurs together with the oak leafroller and damage by the two insects is difficult to separate. Trapping for the oak leaf shredder has been underway in the Maritimes since 1984. A lure for the oak leafroller was tested for the first time in 1988 (see below). Trapping for both insects in the same area should help in understanding the problem.

Oak leafroller - After several years of development at the Forest Pest Management Institute, a new lure for the oak leafroller was successfully tested in 1988. This lure will be used for calibration tests commencing in 1989. The oak leafroller often occurs in the same area as the oak leaf shredder. A pheromone lure for the oak leaf shredder has been in use for some time. Now, with the new lure available, the opportunity exists to monitor the effects of two insects affecting the same resource.

Spruce budmoths - Lures for the spruce budmoth (*Zeiraphera canadensis*) and for the purple-striped shootmoth (*Z. unfortunana*) have been tested for two years. Although both lures attract the appropriate insect, the lure for *Z. canadensis* has not been consistent. More development time is required before a reliable monitoring tool is available and reporting of preliminary trapping results at this time would be premature.

Spruce coneworm - Another lure first tested in the Maritimes in 1988 was for the spruce coneworm, *Dioryctria reniculelloides*. Only 1 of 16 locations trapped was positive. However, most locations trapped were seed orchards and trap captures there do not necessarily reflect the population levels in natural stands. A more extensive trapping program is planned for this pest during 1989.

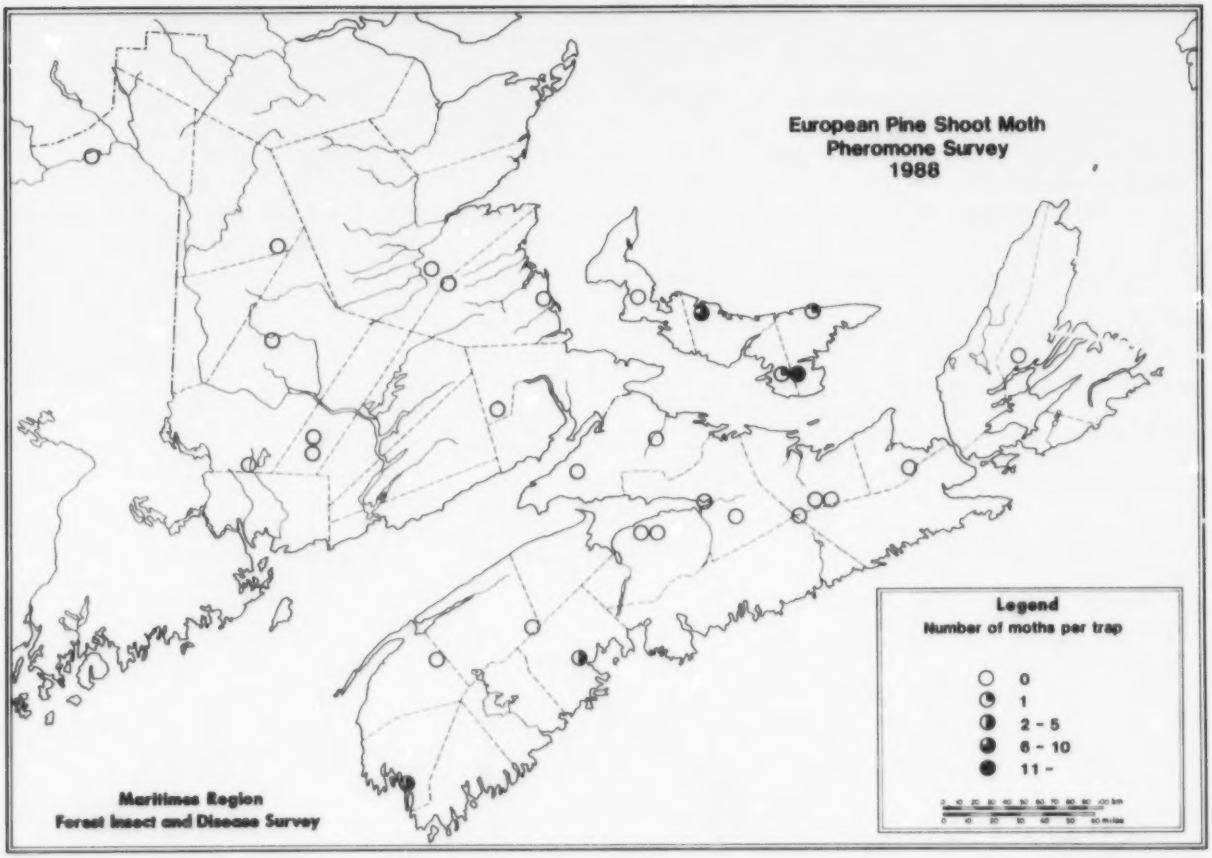


Figure 15

Seedling debarking weevil - Compounds which attract the seedling debarking weevil have been under development for use in ground traps since 1985, by the Forest Insect and Disease Survey and through contracts let to the Research and Productivity Council of New Brunswick. A lure is now available which has been tested by cooperators during 1988. Once calibrations are completed, the lure should provide a reliable survey tool for use in predicting hazard due to the weevil in potential plantation sites.

Gypsy moth - The pheromone trapping detection survey has been used in the Maritimes since 1971. The program is a multi-agency effort and is discussed in detail elsewhere in this report.

THE LIGHT TRAP MONITORING SYSTEM

Taking advantage of the fact that many insects are attracted to light, the Forest Insect and Disease Survey has been using light traps to monitor insect populations since shortly after the Second World War. The trap uses a built-in light source to capture and kill insects, which are then identified and counted. The information is used several ways, such as in designing other types of surveys, predicting population build-ups, and in research.

The 15 light traps in the Maritimes Region listed below are maintained by provincial government cooperators, National Parks personnel, industrial concerns, or private individuals, on behalf of the Forest Insect and Disease Survey; they operate from mid-April until late fall. Catches are collected daily and the material is submitted for identification on a weekly basis. After a period of experimentation during the early years, all traps and light sources were standardized in 1976 and trap locations remained the same except in a few unavoidable situations.

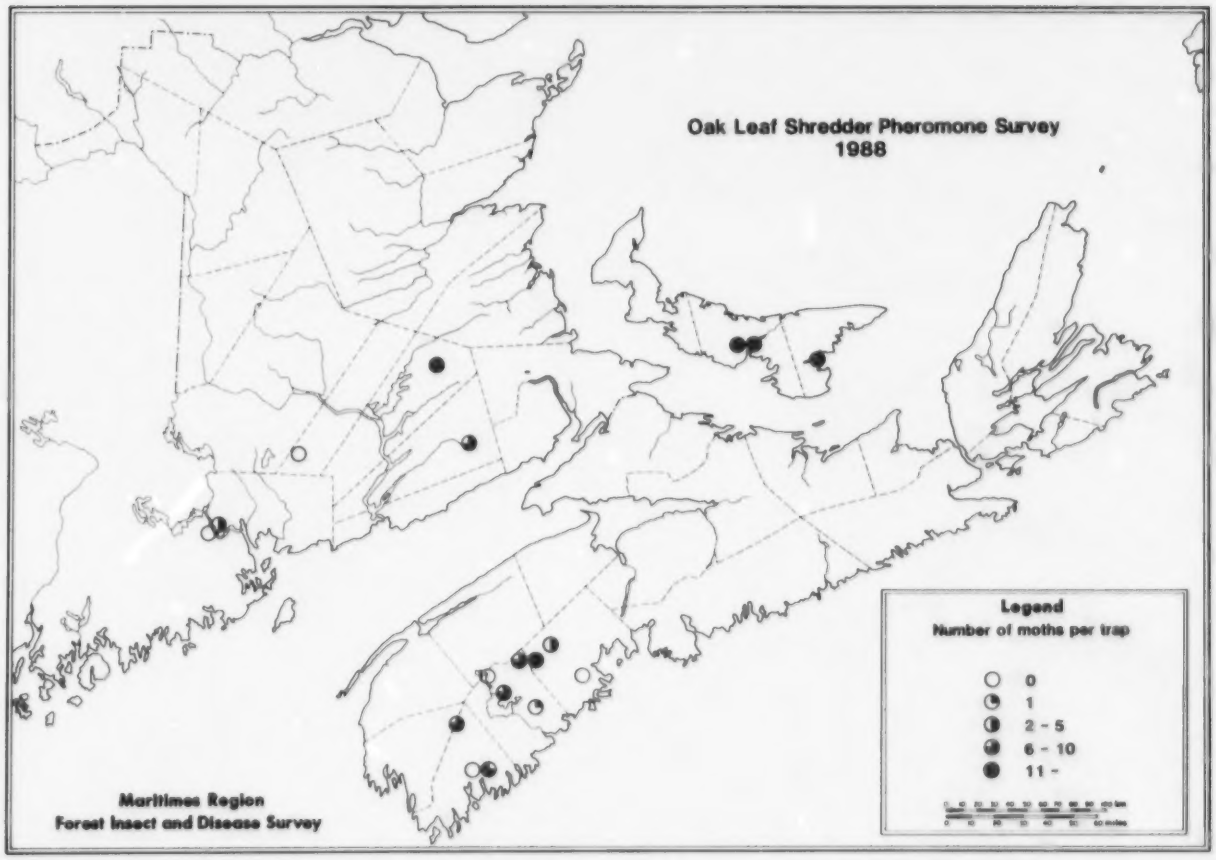


Figure 16

Light trap locations in the Maritimes Region in 1988 were as follows:

New Brunswick

Ashton Hill, Northumberland County
Balmoral, Restigouche County
Canterbury, York County
Fundy National Park, Albert County
Mayfield, Charlotte County
Plaster Rock, Victoria County

Nova Scotia

Big Intervale, Inverness County
Georgeville, Antigonish County
Kejimkujik National Park,
Annapolis County
Lawrencetown, Annapolis County
Liverpool, Queens County
Londonderry, Colchester County

Prince Edward Island

Breadalbane, Queens County
Howlan, Prince County
Kilmuir, Kings County

The light trap with the longest record of operation, located at the old Maritimes Forest Research Centre on the University of New Brunswick campus in Fredericton, N.B., was regretfully discontinued at the end of 1987 when the institution moved to new quarters. Relocation of this trap, probably at Forestry Canada's Acadia Forest Experiment Station near Ripples, Sunbury County, N.B., is planned in 1989.

The results of the light trap operations between 1976 and 1986 have been published in Forestry Canada - Maritimes Information Report M-X-163.

OTHER INSECTS AND DISEASES

This table lists, alphabetically by common name, most insects and diseases encountered in the Maritimes in 1988 but not discussed in detail elsewhere in the report. Inclusion in the table does not imply that the organism is necessarily of lesser economic importance than those discussed in the text. It may be that an organism, eg., larch sawfly, is at an ebb of biological activity and did not cause enough concern in 1988 to warrant detailed discussion. It may be that, although severe, an organism, e.g., poplar leafmining sawfly, was only of localized importance in 1988.

Insect or Disease	Host(s)	Locality	Remarks
Alder flea beetle *Altica ambiens alni* Harr.	Alder	Region	Patches of moderate and severe browning along the St. John River valley to Edmundston and in south-western New Brunswick; also throughout much of Nova Scotia. Populations increased in eastern Prince Edward Island, browning was severe in the Montague-Cambridge-Roseneath area of Kings County.
Anthracnose of maple *Kabatiella apocrypta* (Ell. and Ev.) Arx	Red maple Sugar maple	N.B. N.S.	Intensity variable in New Brunswick, mostly in the north; severe and moderate browning of sugar maple at Thibodeau Brook, Madawaska Co. Trace to light levels of infection at scattered locations in several counties in Nova Scotia.
Ants Formicidae	Conifers	N.B. P.E.I.	In New Brunswick, 12% of small balsam fir trees killed at North Forks, Queens Co. In Prince Edward Island, high populations continued in newly established plantations.
Ash yellows	Ash	Region	Not found in the Region to date. This disease is present in the United States and is of concern to plant quarantine officials.
Aspen leafrollers *Epinotia criddleana* (Kft.) *Pseudexentera oregonana* (Wlshm.) Darkheaded aspen leafroller *Anacampsis innocuella* (Zell.) Lightheaded aspen leafroller *Anacampsis niveopulvella* (Cham.) Spotted aspen leafroller *Pseudosciaphila duplex* (Wlshm.)	Aspen	Region	Leafrolling, mostly of trembling aspen remained common throughout the Region. Leafrolling at Aylesford East, Kings Co., N.S. declined to 35% from 64% in 1987. Trace or light leafrolling elsewhere.
Aspen webworm *Tetralopha aplastella* (Hist.)	Trembling aspen	Region	Very low populations in a few scattered locations, except at Curtis Settlement, Northumberland Co., N.B., where 71% of leaves were rolled and all trees were affected.
Atmospheric impurities	White pine	N.S.	Tree crowns, near a tin mine at East Kemptville, Yarmouth Co., showed no signs of the damage reported in 1987.
Bagworm *Thyridopteryx ephemeraeformis* Haw.	Spruce	Region	No reports in 1988.

Insect or Disease	Host(s)	Locality	Remarks
Balsam bark weevil *Pissodes dubius* Rand.	Balsam fir White spruce Black spruce Red spruce	Region	Common on dead and dying balsam fir in New Brunswick (12% of trees affected at 12 locations in six counties); also found on spruces. An average of 17% of white spruce affected in Queens Co., P.E.I. (4 locations). Only one sample from Nova Scotia.
Balsam fir bark beetle *Pityokteines sparsus* (Lec.)	Balsam fir	Region	Common in weakened trees in New Brunswick: 32% of trees affected near Cranberry Lake, Queens Co., 16% at Shaw Brook, Westmorland Co. Scarce in Nova Scotia, not found in Prince Edward Island.
Balsam fir sawfly *Neodiprion abietis* (Harr.)	Balsam fir Red spruce White spruce	Region	Present in very low numbers at scattered locations in Nova Scotia, not reported from the other provinces.
Balsam shootboring sawfly *Pleroneura brunneicornis* Roh.	Balsam fir	Region	Populations increased and became more widespread in north-eastern New Brunswick and in some areas in Nova Scotia; however, damage levels remained low. A few larvae at one location in Prince Edward Island.
Beech bark disease *Nectria coccinea* var. *faginata* Lohm., Wats. & Ayers and **Beech scale** *Cryptococcus fagisuga* Lind.	Beech	Region	Cankered trees remain common throughout the Region.
Birch sawfly *Arge pectoralis* (Leach)	Yellow birch	N.S.	Light defoliation at only one location.
Black leaf blister *Taphrina dearnessii* Jenkins	Red maple	N.B. N.S.	Affected 23% of leaves on 60% of the trees at Boularderie East, Victoria Co., N.S. Infections lower elsewhere in the two other provinces.
Bruce spanworm *Operophtera bruceata* (Hlst.)	Pin cherry Red maple	N.S.	Found at a single location in each of Cape Breton and Kings counties.
Canker of larch *Potebniamyces coniferarum*	Tamarack	Region	Found at five locations in Nova Scotia and one in Prince Edward Island. No report from New Brunswick.
Cedar leafminers *Argyresthia aureoargentella* Brower *Argyresthia freyella* Wlshm. *Coleotechnites thujaella* (Kft.)	Cedar	N.B. P.E.I.	In New Brunswick, 57% of shoots infested at Latimer Lake, St. John Co., populations low elsewhere. In Prince Edward Island, trees continued to deteriorate in the Wellington, Muddy Creek, and Miscouche areas of southern Prince County.
Cherry blight	Choke cherry Pin cherry	Region	Present at varying levels of intensity throughout much of the Region: severe in Kent and Westmorland counties, New Brunswick; moderate and severe in eastern Nova Scotia; and many trees with severe infections throughout Prince Edward Island.
Cherry casebearer *Coleophora pruniella* Clem.	Trembling aspen	Region	At endemic levels throughout the Region.

Insect or Disease	Host(s)	Locality	Remarks
Conifer aphids *Cinara* spp.	Conifers	Region	Populations declined to low levels throughout the Region.
Deer browsing	Red pine Red spruce	N.B. N.S.	Damage on a few red pine at Caribou Depot, Restigouche Co., N.B. Light browsing in Nova Scotia on red pine at Halfway River, Annapolis Co., and on red spruce at East Kemptville, Yarmouth Co.
Deterioration of cedar	Cedar	N.B.	Condition of cedar trees in Charlotte and St. John counties continued to improve in 1988. Thin crowns with dead branches were still evident, damage by cedar leafminer and brown cedar leafminer was light. Initial cause of the deterioration remains uncertain.
Dieback	White birch Red maple	N.S.	Crown dieback of red maple at Oak Park, Shelburne Co., and red maple and white birch at Beaver River, Yarmouth Co., continued but at a much reduced rate. Trees are under stress in wet sites with open exposures.
Diplodia tip blight *Sphaeropsis sapinea* (Fr.) Dyko & Sutton	Red pine Austrian pine	N.S.	Present on a few ornamental trees in Queens, Lunenburg, and Yarmouth counties.
Eastern blackheaded budworm *Acleris variana* (Fern.)	Balsam fir	Region	Present in very low numbers in New Brunswick and Nova Scotia. No reports from Prince Edward Island.
Eastern dwarf mistletoe *Arceuthobium pusillum* Peck	Spruce	Region	Affected 44% of white spruce trees at Doctors Brook, Antigonish Co., N.S.; uncommon elsewhere.
Eastern spruce gall adelgid *Adelges abietis* (L.)	Red spruce White spruce	Region	Present throughout the Region, generally at trace to light infestation levels. Highest infestations were 36% of shoots affected at The Rocks, Charlotte Co., N.B.; 23% at Robert Brook, Inverness Co., N.S.; and 13% at Goose River, Kings Co., P.E.I.
Eastern tent caterpillar *Malacosoma americanum* (F.)	Apple Cherry	Region	Populations generally low in New Brunswick and Nova Scotia although more common in southern New Brunswick than in 1987. Not found in Prince Edward Island.
Elm leaf aphid *Tinocallis ulmifolii* (Monell)	Elm	N.B.	The outbreak reported at Fre ton, York Co. in 1987, collapsed.
Elm leaf beetle *Pyrrhalta luteola* (Mull.)	Elm	N.B.	Trace foliage discoloration at Fredericton, York Co.
Elm leafminer *Fenusa ulmi* Sund.	Elm English elm Rock elm	Region	Present at various intensity levels throughout, wherever exotic elms are present. Moderate to severe leaf browning common in Nova Scotia and Prince Edward Island.

Insect or Disease	Host(s)	Locality	Remarks
European pine sawfly *Neodiprion sertifer* (Geoff.)	Scots pine Austrian pine Mugho pine Red pine	Region	Moderate defoliation on 20% of Scots pine at Clyde River; light defoliation of Austrian pine at North Winslow and of Scots pine at Cavendish; found on a single red pine in a plantation at Mount Albion, all in Queens Co., P.E.I. In Nova Scotia, found on red pine and mugho pine at four locations. No reports from New Brunswick.
European pine shoot moth *Rhyacionia bouliana* (D. & S.)	Red pine	Region	Populations low throughout the Region; the highest level of shoot damage was 13% at Maitland, Lunenburg Co. in Nova Scotia; 13% at Auburn, Queens Co. in Prince Edward Island.
European spruce sawfly *Gilpinia hercyniae* (Htg.)	Spruce	Region	Populations remained low throughout the Region.
Fall cankerworm *Alsophila pometaria* (Harr.)	Hardwoods	Region	Populations remained low throughout following the 1987 collapse. Light defoliation of mature elms occurred at Montague, Kings Co., P.E.I.
Fall webworm *Hyphantria cunea* (Dru.)	Deciduous	Region	Scattered roadside nests in parts of southern New Brunswick, throughout Nova Scotia (particularly the central and western counties), and throughout much of Prince Edward Island. Populations increased in Prince and Queens counties.
Fir coneworm *Dioryctria abietivorella* (Grt.)	Balsam fir White spruce	N.S.	Trace damage to balsam fir and white spruce cones at locations in Colchester and Inverness counties. At South Cape Highlands, Inverness Co., 5% of the cones damaged on 40% of balsam fir.
Flat leaftier *Psilocorsis reflexella* Clem.	Trembling aspen Largetooth aspen White birch Red oak	Region	Trace or light leaf tying in all three provinces. Highest levels recorded were: 10% of leaves on 60% of trembling aspen in Queens Co., N.B.; 40% of red oak leaves tied in an area in Shelburne Co., N.S.; only a few larvae in Prince Edward Island.
Flooding	White cedar	N.B.	Roadside cedar trees were killed along a 250 metre stretch by small stream flooding at Fielding, Carleton Co.
Forest tent caterpillar *Malacosoma disstria* Hbn.	Hardwoods	Region	Populations remained very low throughout the Region.
Foureyed spruce bark beetle *Polygraphus rufipennis* (Kby.)	Black spruce Red spruce White spruce	Region	Found at eight scattered locations in New Brunswick with an average of 10% of trees affected. A few beetles collected in Nova Scotia, none in Prince Edward Island.

Insect or Disease	Host(s)	Locality	Remarks
Frost damage	Conifers Hardwoods	N.B. N.S.	Frost damage severe and widespread in northern New Brunswick on balsam fir and spruce: all new white spruce shoots killed in an open growing area of 3-4 ha at LeClerc, Restigouche Co.; balsam fir foliage severely damaged at Kedgwick River, Restigouche Co. and near Nictau Lake, Northumberland Co.; moderate and light shoot damage in many other areas of the Province. In Nova Scotia, an average of 6% of white spruce and an average of 3% of balsam fir shoots damaged: at South Cape Highlands, Inverness Co., 44% of white spruce shoots killed; light and trace damage on red spruce, red maple, yellow birch, and pin cherry at several other locations.
Globose gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Jack pine Scots pine Lodgepole pine	N.B. P.E.I.	Common on jack pine in southern New Brunswick in plantations and natural stands and found on lodgepole pine at Acadia Forest Experiment Station. Scots pine Christmas trees at Murray River, Kings Co., and scattered ornamentals at Breadalbane, Queens Co., infected in Prince Edward Island.
Greenheaded spruce sawfly *Pikonema dimmockii* (Cress.)	Spruce	Region	Populations low throughout the Region.
Greenstriped mapleworm *Dryocampa rubicunda rubicunda* (F.)	Red maple	Region	Populations low in all three provinces.
Hail damage	Red maple Trembling aspen	N.S.	Moderate damage to red maple at Lantz, Hants Co. Trembling aspen trees over 4 100 ha near Lake George, Kings Co., have thin crowns as a result of hail damage suffered in 1987.
Ink spot of aspen *Ciborinia whetzelii* (Seaver) Seaver	Trembling aspen	N.B.	Low levels of infection at a few scattered locations.
Jack pine budworm *Choristoneura pinus pinus* Free.	Jack pine	Region	At endemic levels throughout the Region.
Larch needleworm *Zeiraphera improbana (Wlk.)*	Tamarack	N.S.	Few larvae at one location each in Cape Breton and Inverness counties.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Japanese larch Tamarack	Region	Severe defoliation on an experimental Japanese larch plantation, at MacDonald's Corner, Queens Co., N.S., and on larch in an area in Prince Co., P.E.I. No reports from Nova Scotia.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen Wire birch	Region	No reports in 1988.

Insect or Disease	Host(s)	Locality	Remarks
Leaf and twig blight of aspen *Venturia macularis* (Fr.) Muell. & Arx.	Trembling aspen Largetooth aspen Balsam poplar	Region	Common throughout the Region; shoot damage averaged 16% in New Brunswick (23 locations, highest 62%), 4% in Nova Scotia (29 locations, highest 21%) and "light only" in Prince Edward Island.
Leaf blister *Taphrina carnea* Johanson	White birch Yellow birch	N.B. N.S.	Moderate infection in Fundy National Park, Albert Co., N.B. (63% of white birch leaves affected) and at Donahue Lake, Guysborough Co., N.S. (36% of yellow birch leaves affected). Light or trace infection in a few other areas in the two provinces.
Leaf blotch of horse-chestnut *Guignardia aesculi* (Peck) V.B. Stew	Horse-chestnut	Region	Severe leaf browning common throughout Nova Scotia with both intensity and incidence increased from 1987 levels. Infection levels unchanged in New Brunswick with light foliage browning wherever the host is found. No report from Prince Edward Island.
Leafrollers on birch *Caloptilia* sp.	White birch Wire birch Yellow birch	N.B. N.S.	Leafrolling light throughout New Brunswick, an increase from trace in 1987. Found only at two locations in Nova Scotia.
Leaf spot of poplar *Drepanopeziza tremulae* Rimpau	Trembling aspen Largetooth aspen	N.B. N.S.	Severe leaf browning in parts of Kent, Northumberland, and Queens in New Brunswick. Browning of all leaves on all trees Smith Cove, Digby Co. and Parrsboro, Cumberland Co.; almost as severe at Lumsden Dam, Kings Co. in Nova Scotia. Widespread elsewhere in much of the province with intensity of browning much higher than in 1987.
Lesser aspen webworm *Meroptera pravella* (Grt.)	Trembling aspen	Region	Not found in 1988.
Lesser maple spanworm *Itame pustularia* (Gn.)	Red maple	Region	Populations very low throughout the Region.
Maple leafroller *Sparganothis acerivorana* MacK.	Red maple Sugar maple	Region	Moderate leafrolling on red maple at Middle River, Gloucester Co., N.B. Light or trace leafrolling elsewhere in the Region. No leafrolling at Central Bedeque, Prince Co., where it was severe in 1987.
Mites *Oligonychus milleri* (McGregor)	Jack pine Red pine	Region	All needles discolored on all red pine trees in a plantation in the Stanley Management Area, Hants Co., N.S. Population very low elsewhere.
Oligonychus ununguis (Jacobi)	Balsam fir Red spruce	N.B. N.S.	Light or trace discoloration at a few locations.

Insect or Disease	Host(s)	Locality	Remarks
Mottled and discolored foliage	Conifers Hardwoods	N.B. N.S.	Various levels of foliage discoloration of several coniferous and deciduous species. Cause unknown, but probably varies by location and species. Tree species affected: in New Brunswick - moderate on black spruce, white birch and red maple in Northumberland Co., on sugar maple in Gloucester Co., and on red maple in Albert Co.; in Nova Scotia -severe on black spruce in Victoria Co., on red pine in Yarmouth Co., on red maple in Hants Co., and on red spruce in Annapolis, Cumberland and Halifax counties, moderate on eastern white pine in Queens Co., on balsam fir in Antigonish Co., and on larch in Digby and Hants counties.
Mountain ash sawfly *Pristiphora geniculata* (Htg.)	Mountain ash	Region	Populations declined further in New Brunswick, only a few larvae found at Richibucto, Kent Co. In Nova Scotia, defoliation was moderate on ornamentals at Sydney, Cape Breton Co. and light at scattered locations. No reports from Prince Edward Island.
Needle casts *Davisomycella ampla* (Davis) Darker	Jack pine	N.B.	Moderate infection on two trees at Mt. Hebron, Kings Co.
Lirula macrospora (Hartig) Darker	Red spruce Blue spruce Black spruce White spruce	N.B. N.S.	Moderate or light at a few scattered locations in New Brunswick; common throughout Nova Scotia at low levels of intensity.
Lirula nervata (Darker) Darker	Balsam fir	N.B. N.S.	At low infection levels at a few locations.
Northern cedar bark beetle *Phloeosinus canadensis* Sw.	Cedar	N.B.	Fewer red flags in the areas of Carleton County where they were very noticeable in 1987.
Northern pitch twig moth *Petrova albicapitana* (Busck.)	Jack pine Scots pine Lodgepole pine	Region	Widespread at low populations in jack pine plantations in New Brunswick and Nova Scotia. Considerable damage in a lodgepole pine plantation at the Acadia Forest Experiment Station, Sunbury Co., N.B. with 10% tree mortality; 56% of jack pine trees affected in an area northwest of Caledonia, Guysborough Co. No records from Prince Edward Island.
Obliquebanded leafroller *Choristoneura rosaceana* (Harr.)	Trembling aspen Yellow birch White birch	Region	A few rolled leaves at scattered locations in New Brunswick and at one location in Kings Co., Prince Edward Island. No reports from Nova Scotia.

Insect or Disease	Host(s)	Locality	Remarks
Ocean salt spray	Spruce Hardwoods	Region	Severe or moderate foliage browning at Ste. Anne-de-Kent, Kent Co., N.B.; severe browning of white spruce between LaButteurse and Corney Brook, Inverness Co., N.S. where light foliage discoloration of hardwoods also occurred. In Prince Edward Island National Park, the sides of trees exposed to the Gulf of St. Lawrence have no foliage. High on-shore winds were observed on a clear day, blowing salt spray clouds ashore.
Orangehumped mapleworm *Symmerista leucitys* Francl.	Beech	Region	Populations very low, the only records in the Region in 1988 were a single adult in the light trap and a single larva in Kejimkujik National Park, N.S.
Pepper-and-salt moth *Biston betularia cognataria* (Gn).	Tamarack Red maple	N.S. P.E.I.	Trace defoliation at only one location in each of the two provinces.
Pine bark adelgid *Pineus strobi* (Htg.)	Pine	Region	Widely distributed and common, causing light infestations at scattered locations in New Brunswick and Nova Scotia.
Pinkstriped oakworm *Anisota virginiensis virginiensis* (Drury)	Red oak	Region	No reports in 1988.
Poplar leaffolding sawfly *Phyllocolpa* sp.	Trembling aspen	Region	Populations increased from 1987 levels in New Brunswick and Prince Edward Island, but decreased in Nova Scotia; an average of 21% of leaves affected in N.B. (29 locations), 4% in N.S. (33 locations), and 13% in P.E.I. (8 locations). The number of trees affected at these locations averaged 71%, 64%, and 51%, respectively.
Poplar leafmining sawfly *Messa populifoliella* (Town.)	Trembling aspen	Region	In New Brunswick, severe or moderate leaf damage in areas of Kings and Restigouche counties and on ornamentals in Fredericton, York Co. Moderate leafmining at Duvar, Prince Co., P.E. I. No records from Nova Scotia.
Poplar petiolegall moth *Ectoedemia populella* Busck	Trembling aspen	N.S. P.E.I.	Found at 6 locations in 4 counties in Nova Scotia; 61% of leaf petioles affected at Maryvale, Antigonish Co.; 53% at Four Mile Brook, Pictou Co., and 51% at Athol, Cumberland Co.; one location each in Kings and Queens counties, Prince Edward Island.
Porcupine damage	Balsam fir Jack pine Tamarack Red pine White pine	N.B. N.S.	Damage common throughout New Brunswick and Nova Scotia. 3-44% of trees were damaged in seven counties in N.B.; the most damage occurring on jack pine at Tracadie Camp, Gloucester Co. In Nova Scotia, damage ranged from 4% to 92% in nine counties, including 92% in a jack pine plantation at Indian Fields, Shelburne Co., and 70% in a red pine plantation at Lake Joli, Digby Co.

Insect or Disease	Host(s)	Locality	Remarks
Premature needle loss	Black spruce	N.B.	Premature loss of the previous year's foliage continued in 1988 in black spruce plantations in Victoria and Madawaska counties but at slightly reduced levels: 52% of one-year-old needles lost in the spring of 1988 compared to a 75% loss in 1987.
Rabbit damage	Balsam fir Tamarack Red pine	Region	Moderate damage to balsam fir at Lepreau Falls, St. John Co.; light elsewhere in a few other areas in New Brunswick and Nova Scotia. No reports from Prince Edward Island.
Ragged spruce gall adelgid *Pineus similis* (Gill.)	Red spruce White spruce	Region	Scattered, generally of light intensity in the Region; highest occurrence being 21% of red spruce shoots infested at Graywood, Annapolis Co., N.S. and 9% of shoots affected on 50% of white spruce at Riverdale, Queens Co., P.E.I.
Redheaded jack pine sawfly *Neodiprion virginiana complex*	Jack pine Scots pine	Region	No reports in 1988.
Red flagging of balsam fir *Fusicoccum abietinum* (Hartig) Prill. & Delacr	Balsam fir	N.S.	Observed on 56% of trees at Bericham, Colchester Co.
Red pine cone beetle *Conophthorus resinosae* Hopk.	Red pine	Region	No reports in 1988.
Red shoots	Balsam fir	N.B. N.S.	Discolored shoots observed on 40% of trees at Upper Tetagouche Lake, Restigouche Co., N.B.; and noted on scattered roadside trees in Hants, Halifax, and Cumberland counties. The cause is undetermined.
Red spruce adelgid *Pineus floccus* (Patch)	Red spruce Black spruce	N.B. N.S.	Light damage at seven locations in New Brunswick and at four in Nova Scotia. Highest level of infestation found at Goshen, Albert Co., N.B. where 21% of red spruce shoots were affected.
Resin flow	White spruce	P.E.I.	Pitch flow is a continuing problem on the underside of white spruce branches in southern Kings County. Cause unknown.
Roadside salt damage	Conifers	N.B. N.S.	Foliage discoloration severe or moderate in many areas of New Brunswick and Nova Scotia. Most visibly affected species were, as usual, white pine and red pine.
Saddled prominent *Heterocampa guttivitta* (Wlk.)	Sugar maple	Region	At endemic levels.

Insect or Disease	Host(s)	Locality	Remarks
Satin moth *Leucoma salicis* (L.)	Silver poplar Carolina poplar	Region	Populations generally down in New Brunswick, severe defoliation only at St. Leonard, Madawaska Co. on silver poplar. Only trace defoliation of Carolina poplar at New Maryland, York Co., where severe defoliation occurred in 1987. In Prince Edward Island, severe defoliation on scattered silver poplar trees at Murray Harbor and Belfast, Kings Co.; Cherry Valley, New Haven; and Marshfield, Queens Co. Moderate defoliation at St. Peters, Kings Co., and Kensington, Prince Co. No noticeable defoliation found in Nova Scotia.
Snow damage	Conifers	Region	Damage to 40% and 32% of red pine trees at Taylor Lake and Cox Brook road, Pictou Co., N.S., respectively. Scattered damage elsewhere in the Region.
Spearmarked black moth *Rheumaptera hastata* (L.)	White birch	N.B.	Encountered at four scattered locations at low levels.
Spittlebugs *Aphrophora* sp.	Conifers	Region	Present at low levels throughout Nova Scotia, found in two areas in New Brunswick and at one location in Prince Edward Island.
Cercopidae	White spruce Balsam fir White birch Red maple Red oak Alder	N.S.	Present in low numbers throughout the Province.
Spring cankerworm *Paleacrita vernata* (Peck)	Elm	N.S.	At endemic levels.
Spruce bud midge *Rhabdophaga swainei* Felt	Black spruce Red spruce White spruce	Region	Populations low but widespread throughout.
Spruce bud scale *Physokermes piceae* (Sch.)	Black spruce Red spruce White spruce	Region	Common throughout Nova Scotia, especially on red spruce; 78% and 66% of shoots infested at Cape Blomidon, Kings Co. and south of Mink Lake, Yarmouth Co., respectively. Widespread but only at trace level in Westmorland and Albert counties, New Brunswick; found at one location in Prince Edward Island.
Spruce cone maggot *Hylemya anthracina* (Czerny)	Red spruce White spruce	N.S.	Common in Province, damage generally low, however 46% and 35% of white spruce cones were affected at Whycocomagh, Inverness Co. and north of Earltown, Colchester Co., respectively.
Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun.	Spruce	Region	Populations remained generally low throughout the Region, however, 52% of white spruce cones were damaged, in association with spruce budworm, at Cavendish, Queens Co., P.E.I.

Insect or Disease	Host(s)	Locality	Remarks
Spruce gall adelgid *Adelges lariciatus* (Patch)	Red spruce White spruce Larch	Region	Present at low numbers at one location in New Brunswick (damage light) and at scattered locations in Nova Scotia (damage trace). No reports from Prince Edward Island.
Spruce twig aphid *Mindarus obliquus* (Cholod)	Black spruce Red spruce White spruce	Region	Light to moderate damage with an average of 9% of shoots affected at 23 locations in 15 counties in Nova Scotia. Highest infestation recorded at Middle Sackville, Halifax Co., where all red spruce trees were affected and 63% of the shoots were damaged. Found at one location each in the two other provinces.
Sugar maple borer *Glycobius speciosus* (Say)	Sugar maple	Region	Present throughout the Region at varying levels of incidence.
Sulphur dioxide damage	Conifers Hardwoods	N.B.	Trees continued to deteriorate in natural stands and some mortality of conifers occurred in a plantation near a base metal smelter in Gloucester County.
Tar spot of maple *Rhytisma acerinum* (Pers. ex St. Amans) Fr.	Maple	N.B. N.S.	Found at scattered locations, infected leaves averaged 20% and 29% in New Brunswick and Nova Scotia, respectively. As many as 92% and 88% of leaves infected at Neils Harbor, Victoria Co. and Ogden, Guysborough Co., respectively, in Nova Scotia.
Uglynest caterpillar *Archips cerasivorana* (Fitch)	Cherry Alder Apple Red oak Sugar maple	Region	Common in all three provinces with many nests present in numerous areas. In New Brunswick nest counts decrease towards the north from "too numerous to count" at New Maryland, York Co. to 30/100 m² at Comeau Ridge, Madawaska Co.; in Nova Scotia, populations at about 1987 levels with frequent counts of 25/100m²; in Prince Edward Island, counts averaged 29/100m² at seven locations in Prince County with a maximum of 71/100m² at Duvar.
Wax filament scale *Xylococculus betulae* (Perg.)	White birch Beech	Region	Infestations are generally light in both New Brunswick and Nova Scotia except at three locations in Fundy National Park where more than three quarters of birch trees were infested. No reports from Prince Edward Island.
Weevil damage *Strophosoma melanogrammum* Forst.	Red pine	N.S.	A general feeder of no previously reported economic importance, the weevil caused severe defoliation in young, 2-0, red pine plantations in Cape Breton Co., N.S. In addition to feeding on needles of conifers, young stems are also damaged. Weevils were found on white birch foliage, as well as on conifers.
White pine blister rust *Cronartium ribicola* J.C. Fisch.	White pine	Region	Present throughout the Region; 56% of trees affected at North Forks, Queens Co., N.B.
White pine cone beetle *Conophthorus coniperda* (Sz.)	Red pine White pine	Region	No reports in 1988.

Insect or Disease	Host(s)	Locality	Remarks
White pine sawfly *Neodiprion pinetum* Nort.	White pine	Region	Populations decreased from 1987 levels. Found only on a few ornamentals at one location each in York Co., N.B. and Inverness Co., N.S.
White pine weevil *Pissodes strobi* (Htg.)	White pine Scots pine Jack pine White spruce Norway spruce Red spruce Blue spruce Black spruce	Region	Present in plantations, in natural stands and on ornamentals throughout the Region, often causing considerable damage, such as 80% of Norway spruce at Rang-Des-Collin, Madawaska Co.; 36% of white pine at Upper Tetagouche Lake, Restigouche Co., N.B.; 80% of white pine south of Blockhouse, Lunenburg Co., N.S.; 12% of Norway spruce at Stanhope, Queens Co., P.E.I.
Whitespotted sawyer beetle *Monochamus scutellatus* (Say)	Balsam fir White pine Red pine Jack pine Red spruce White spruce Tamarack	Region	Common throughout the Region, infested as many as 44% of balsam fir trees at Guitar, Gloucester Co., N.B. and 25% of trees in both Nova Scotia and Prince Edward Island at some locations.
Willow blight *Venturia saliciperda* Nuesch	Willow	Region	Light to moderate browning at scattered locations in the Region, up slightly from the low levels of 1987.
Willow flea weevil *Rhynchaenus rufipes* (Lec.)	Willow	Region	Moderate or severe leaf browning of ornamental willows at scattered locations throughout.
Wind damage	Conifers Hardwoods	Region	In New Brunswick, a storm in November 1988 uprooted or broke off conifers and some ridge-top hardwoods in the Perth-Plaster Rock area of Victoria Co.; light damage from wind-whipping occurred at Beaconsfield, Victoria Co. In Nova Scotia, summer storms damaged trees in a number of areas: 33% of sugar maple trees had up to 80% of their foliage affected at Belliveau Lake, Digby Co.; moderate damage occurred to red maple at Rocky Mountain, Pictou Co.; hail and strong winds on July 31 damaged foliage of hardwoods and uprooted trees in the Lantz area of Hants Co.; trees, most often red pine, were uprooted in Cumberland, Colchester, Pictou, Antigonish, Victoria, and Cape Breton counties. No reports from Prince Edward Island.
Winter drying	Conifers	Region	Foliage discoloration was generally less pronounced in New Brunswick and Prince Edward Island than in 1987. However, severe browning of Scots pine Christmas trees occurred at Ste. Anne and Martin in Madawaska Co., N.B. In Nova Scotia, moderate or light discoloration of red pine occurred in areas of Guysborough, Colchester, Halifax, and Yarmouth counties.
Winter moth *Operophtera brumata* (L.)	Basswood	Region	Found only on ornamental basswood at Charlottetown, Queens Co., P.E.I.

Insect or Disease	Host(s)	Locality	Remarks
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	Black spruce Red spruce White spruce	Region	Moderate defoliation of black spruce at Lisson Settlement, Kings Co., N.B.; a few larvae at three locations in New Brunswick and 13 locations in Nova Scotia. No reports from Prince Edward Island.
Witches' broom on spruce *Chrysomyxa arctostaphyli* Diet.	Black spruce	N.S.	Present on scattered black spruce trees in Queens, Shelburne, and Yarmouth counties.

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